

EXPORT AGRICULTURE DIVERSIFICATION AND INTRA-REGIONAL
INCOME DISTRIBUTION IN THE IVORY COAST: THE
CASE OF THE FORESTED REGION, 1960-1980

By

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To the memory of my parents
who dedicated so much to their family
and contributed so much to my education

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The economic base of the Ivory Coast forested region and three subregions has, historically, been closely associated with the plantation system, particularly coffee and cocoa. Since the early 1960s, the country has undertaken vigorous investment efforts in the area of national and regional agricultural diversification.

The specific objectives of this study were (a) quantification and analysis of the degree and patterns of export crop diversification, (b) determination of the impact of export crop diversification on producer earnings, (c) evaluation of the effects of export crop diversification on producer earnings stability, and (d) determination of the impact of the existing diversification level on agricultural income distribution structure of the forested zone. Diversification is viewed, conceptually, as the evenness with respect to the relative share of

resources allocated to seven export crops (cocoa, coffee, oil palm, coconut, banana, pineapple, rubber).

The empirical findings indicate that the forested zone and its subregions experienced increases in their levels of diversification over the 1960-80 period. Although the pace of diversification was more active in the Western Forested Region than the Eastern and Central Forested Regions, as well as the forested zone in general, the Eastern Forested Region was nonetheless found to be the most diversified region. The findings strongly suggested that, within a certain range, export crop diversification works against high levels of agricultural earnings, while beyond a critical level of diversification, the process would result in higher earnings levels in the forested zone and two of its three subregions. The findings further indicate that, with the exception of the Western Forested Region, diversification is a means of reducing the magnitude of agricultural earnings variability. The findings also indicate that significant economic growth and regional as well as intra-regional improvement occurred in the income distribution structure of the forested zone over the study period. However, there was some evidence that continuous earning differentials favoring the traditional export crops, concurrent with high and positive output and earnings correlations for some of the crop combinations, would limit the developmental and stabilizing impacts of the diversification process.

CHAPTER I NATIONAL AND GEOGRAPHICAL SETTING

Introduction

The Ivory Coast covers an area of 325,770 square kilometers and is bordered by Ghana on the east, Upper Volta and Mali on the north, and Liberia and Guinea on the West (Figures 1 and 2). The land area is differentiated by agro-ecological zones of natural vegetation. Generally, the forested zone consists of the deep southern region which is densely forested. The midwestern and mideastern regions are covered with tropical forest [1]. Four major rivers, Comoe, twin Bandama, Sassandra, and Cavally, flow southward across the county to the Atlantic Ocean. The Bandama is the longest and the Cavally the shortest of the four major rivers. The Cavally forms a natural frontier between the Ivory Coast and Liberia.¹

The country is inhabited by over 70 ethnic groups.² According to the 1975 national census, the population of the Ivory Coast was 6.7 million. This population was estimated to have reached 8.2 million by the end of 1980 [34]. The 1975 census indicated natural population growth rates of 1.9, 3.1, and 4.0 percent for the periods 1950-1955, 1960-1965 and 1965-1977, respectively. The overall population density

¹The Bandama rivers cover about 950 kilometers within the country, the Comoe 900 kilometers, the Sassandra 650 kilometers and the Cavally 600 kilometers.

²An ethnic group is defined here in terms of differentiation, however small, between various languages, modes of subsistence, and social and political structure.



SUB-SAHARAN AFRICA

Figure 1. Location of the Ivory Coast in Sub-Saharan Africa

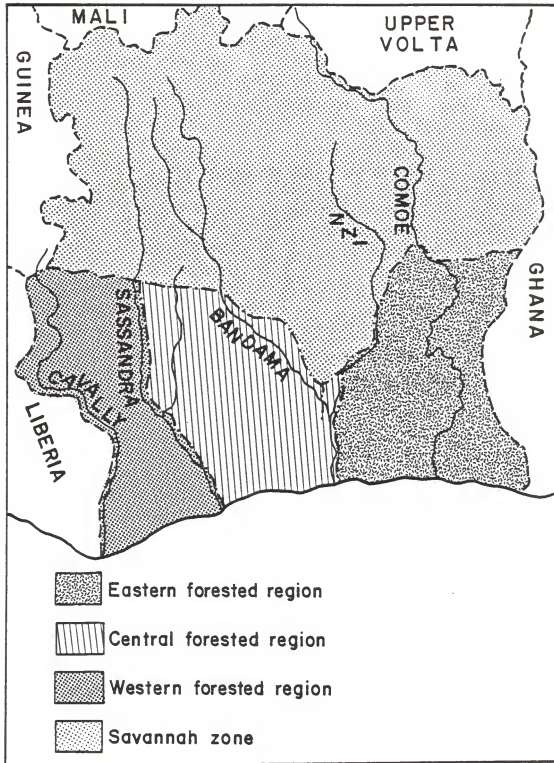


Figure 2. Agro-ecological zones, major rivers and the "V Baoulé" in the Ivory Coast

for the country was 20 persons per square kilometer in 1975. Abidjan, the capital city, has over one million people. In addition to the indigenous ethnic groups, there are other important African ethnic groups residing in the country. These groups are mainly from countries such as Upper Volta, Mali, Senegal and Nigeria. It is estimated that the overall population of the country will range between 14 and 15 million inhabitants by the year 2000 [33].

From an agricultural standpoint, the country can be divided roughly into two major ecological regions: (1) the North, which consists of savannah with trees and grasses, and (2) the South, which is dominated by tropical forests. The savannah region is dominated by food crops, such as millet, sorghum, maize and rice [1]. The central portion of the savannah region penetrates in a V-shaped manner into the forested region (Figure 3). In the South, the Mideast and Midwest, where the natural vegetation is tropical forest, ecological conditions are highly suitable for growing perennial crops, such as coffee, cocoa, oil palm, coconut palm and rubber. In addition to these tree crops, the forested zone is also favorable for growing bananas and pineapples. Yams, plantains, cassava and upland rice are the major food crops grown in the forested region.

The Forested Zone: Overview

Generally, the forested zone can be divided into three subregions: The Eastern Forested Region, the Central Forested Region, and the Western Forested Region.

Eastern Forested Region

This region covers an area extending from the Bandama river to the Ivorian frontier with Ghana. It includes primarily economic and



Figure 3. The forested zone and its major subregions and urban centers in the Ivory Coast

political entities called Departments,³ which are associated with metropolitan centers such as Abidjan, Abengourou, Aboisso, Adzope, Agboville, and Dimbokro (Figure 3). The cultivation of cereals for households consumption is traditionally not common in this area since plantains, yams and other roots are the main staple foods. However, this portion of the country provides significant shares of the major export cash crops such as cocoa, coffee, oil palm, rubber, bananas and pineapples. Indeed, this subforested region was the pioneering zone for the early coffee and cocoa plantations in the Ivory Coast. According to the 1980 Ivorian Agricultural census this region accounted for 32.6 percent of the coffee and 44.4 percent of the cocoa produced in the country during the 1979-80 harvesting period [26]. For crops such as oil palm, coconut and rubber, which were introduced during the national diversification programs of the 1960s, the relative contribution of the region to national output during the 1979-80 harvesting period was respectively, 75.9, 91.5 and 981.1 percent (Table 1). The 75.9 percent regional share for oil palm production represents the geographical contribution to total national hybrid oil palm output from plantations in 1980. As a region of early established cocoa and coffee plantations, the area has consistently accounted for relatively higher shares of regional income. This regional income differential is reflected in the fact that local plantation owners have traditionally been able to hire foreign labor from neighboring countries such as Mali and Upper Volta, while plantation owners in the other areas were depending to some extent on family labor [3].

³ A Department is a territorial entity which has a certain degree of administrative autonomy.

Table 1. Relative output share of the three forested regions for five major crops, Ivory Coast, selected periods, 1960-1980

Regions	1960-61	1970-71	1974-75	1979-80
-----percent-----				
<u>Coffee</u>				
Eastern Forested	46.4	42.7	44.5	32.6
Central Forested	25.3	29.7	31.1	33.5
Western Forested	10.8	15.6	13.5	20.0
<u>Cocoa</u>				
Eastern Forested	59.3	42.7	42.8	44.4
Central Forested	16.8	33.9	43.1	38.6
Western Forested	0.6	1.3	2.0	5.3
<u>Coconut (copra)</u>				
Eastern Forested	--	--	88.0	91.5
Central Forested	--	--	4.0	6.3
Western Forested	--	--	--	2.2
<u>Oil palm (bunch)^a</u>				
Eastern Forested	--	--	8.0	75.9
Central Forested	--	--	8.2	8.6
Western Forested	--	--	9.5	14.4
<u>Rubber</u>				
Eastern Forested	--	--	100.0	98.1
Central Forested	--	--	--	--
Western Forested	--	--	--	1.9

^aHybrid variety.

Source: [22,26].

Central Forested Region

This region stretches from the Bandama river to the Sassandra river. It includes Departments associated with relatively large cities such as Divo, Gagnoa and Daloa. There are also some smaller metropolitan centers in the region such as Bouaflé, Lakota, Toumodi and Yamoussokro (Figure 3). Rice is traditionally grown in this area, primarily around Gagnoa, Daloa and Yamoussokro. The ecological conditions of the region are well-suited for growing most of the export cash crops targeted for the country's diversification program. Estimates based on the 1980 agricultural census indicate that in that year, 33.5 percent of national coffee production, 38.6 percent of cocoa, and 8.6 percent of the total palm bunch harvested were provided by the Central Forested Region (Table 1). There was some indication, however, that local plantation owners in this region were not as economically well-off as their counterparts in the Eastern Forested Region. This impression is related to the relatively small percentage of hired labor utilization in indigenous plantations, compared to that of the Eastern Forested Region indigenous plantations[3].

Western Forested Region

This region lies between the Sassandra and the Cavally rivers. The region includes the Departments of Danané, Guiglo, Man, Sassandra and Biankouma. In terms of food crop production, rice is dominant, followed by crops such as cassava and yam, along with the plantain. As far as export cash crops are concerned, the region produced 0.6 percent and 10.8 percent of the nation's cocoa and coffee, respectively, over the 1960-61 harvesting period. By the 1979-80 period, the relative regional

shares for these crops were 5.3 and 20.0 percent, respectively (Table 1).

Government policy makers and development planners hold high expectations for agricultural sector growth in the Western Forested Region [38,39]. The port of San Pedro, located in the southwest, is viewed as the means of opening up this region and portion of the Central Forested Region to maritime trade. As such, San Pedro is expected to play a major role in the economic development of the midwestern and western regions of the country.

The Economic Structure of the Forested Region

Evolution of the Plantation System

The economic base of the forested zone has historically been closely linked to the plantation system, particularly cocoa and coffee. In the 1890s the economic potential of the Ivory Coast was not fully exploited by the French colonial administration. At that time development efforts were concentrated on peanut production in Senegal. In the Ivory Coast, the need for full political and military control of the region was the first priority of the French administration. This priority was a direct result of the strong military resistance mounted by Samory⁴ against French settlement in the forested region. The protracted struggle for control of the region impeded the development of a transportation network linking the various regions within the country. Total political and military control by the French administration was not achieved until after the Second World War.

⁴Samory was a West African king who fought the French for 18 years before being defeated and captured in 1898 in a remote village of the Ivory Coast.

Coffee Plantations

Coffee was first introduced in the southern region of the Ivory Coast in 1881 [33]. The early coffee plantations performed poorly, due to inadequate know-how and managerial skills. During the 1920's pioneering European planters extended the cultivation of mixed coffee varieties to the eastern, southern, central, midwestern and western regions of the forested zone. By 1929, a research station concentrating on the robusta coffee variety was established at Man in the Western Forested Region (Figure 3). Also, during the 1930s the indigenous variety gros indenié was developed at a research site at Bingerville, in the Eastern Forested Region. Although qualitatively inferior to the robusta variety, this variety was more resistant to local weather conditions.

As a result of the 1949-50 tracheomycosis disease, vast areas of old coffee plantations were replanted with the robusta ineac variety imported in 1935 from the Belgian Congo (Zaire). Domestic propagation and distribution of tracheomycosis resistant varieties were the responsibility of the research center at Bingerville. The national coffee fund, financed from a tax on coffee export revenues, was diverted from its price and income stabilization function to finance the replanting and production efforts. Also, further research was undertaken to develop improved and adaptive coffee varieties. Under this intensified research program, one such variety was successfully developed by the late 1960s [47]. The 1971-75 Development Plan also accorded high priority to the replanting of most coffee farms with selected varieties, under a system of intensive cultivation. At the same time, the total area under coffee cultivation was programmed to be

reduced. This planned reduction was partly due, on one hand, to recognized constraints to output expansion on the demand side, and, on the other hand, to the necessity of freeing land for the new crops projected under the national diversification programs of the 1960s.

Cocoa Plantations

As late as 1908, cocoa was grown only on few and scattered plantations in the Ivory Coast. In contrast, commercial cocoa plantations were established as early as the 1890s in the neighboring British colony of Ghana. In the years following 1908, the French colonial administration launched an aggressive cocoa production program among native and European farmers. This policy was facilitated by the ability to produce superior varieties as a result of research conducted at the Bingerville station, and by the existence of a ready-made market for Ivorian Cocoa in France. However, the sharp decline in world cocoa price during the 1930s led to a slowing down of the rate of cocoa planting.

The major problem confronting the cocoa subsector after World War II was not one of disease. Instead, the difficulties were associated with aging cocoa trees on one hand, and with losses in production due to capsid insects on the other hand. The approach used for resolving the difficulties associated with aging was to remove old trees as well as younger diseased trees. New selected cocoa varieties were then planted and maintained by a pest control program financed by a cocoa fund. The program for eradication of capsid insects gained momentum in 1959. When the country became independent in 1960, the anticapsid program was followed by the cocoa regeneration program. The primary objective of these programs was to increase average yields. The 1971-75 Development

Plan called for future cocoa planting to be confined to higher yielding hybrid varieties.

Banana Plantations

Banana cultivation was introduced into the Ivory Coast on a commercial basis in the early 1930s. The early banana plantations were first established in the Sassandra area of the Western Forested Region. By 1939 the Ivory Coast was able to produce 10,000 metric tons of banana [3]. The early *sinensis* variety was highly susceptible to disease, and as a result, was almost completely replaced by the more resistant *poyo* variety by 1950. The tremendous development of this export cash crop in the 1960s was made possible by the existence of a high level of demand for bananas in France and other European Economic Community (EEC) countries. The high demand for Ivorian banana in the French market was associated with two major events. The first event was the withdrawal of Guinean banana from the French market in the 1959-60 period. The second event was the reduced output from the French Antillese as a result of the 1963 hurricane disaster in that area. The combination of these events stimulated banana production in the Ivory Coast to the point that the country is now the largest banana producer in Africa.

Pineapple and Oil Palm Plantations

Pineapple plantations were established in the Ivory Coast in the early 1950s. In 1952 only 1,100 metric tons of fresh fruits were produced (Table 2). By 1962, 32,900 metric tons of fresh fruits were produced which represents 2,891 percent increase in the pineapple production over the 1952-1962 period [3]. The bulk of pineapple is processed into slices and/or juice for the export market. Expansion in

Table 2. Estimates of production levels for selected crops in the forested zone at estimated average export prices, Ivory Coast, selected years, 1950-1958.

Commodities	-----thousand metric tons-----					-----million CFA francs-----				
	1950	1952	1954	1956	1958	1950	1952	1954	1956	1958
Coffee	39.7 (0.73) ^a	47.8 (0.75)	60.5 (0.69)	80.6 (0.69)	91.0 (0.81)	4,890.3	7,919.6	11,300.2	10,268.7	15,190.0
Cocoa	41.4 (0.67)	49.5 (0.99)	46.3 (0.88)	59.3 (0.78)	38.0 (0.82)	3,157.6	6,089.8	7,759.5	6,579.5	5,261.4
Banana	20.3 (0.88)	21.8 (1.2)	21.9 (1.0)	28.9 (1.2)	43.6 (0.94)	309.2	338.2	331.7	395.2	1,204.5
Pineapple	9.8 (98.0)	1.1 (4.6)	4.2 (17.8)	8.6 (23.3)	14.8 (14.9)	284.2	8.7	156.6	242.2	485.1
Palm Oil	5.9 (5.9)	8.6 (4.8)	5.3 --	8.0 (4.1)	7.5 (9.1)	0.2	0.3	0.2	0.4	0.4
Total	117.1	128.8	138.2	185.4	194.9	8,641.5	14,406.6	19,548.2	17,486.0	22,141.4

^aThe figures in parentheses are ratio of production of the forested region to the total quantities exported for the selected commodities. Economic implications of the size of these ratios are discussed in the text.

Source: Computations based on data published in [36].

the pineapple production can be directly attributed to the high priority accorded to this commodity in the national agricultural diversification program initiated in the 1960s.

In the forested region, other cash crop activities, such as palm oil production, were not as significant as those of coffee, cocoa, banana and pineapple. Specifically, it has only been in the post-independence era that the effectiveness of the oil palm industry became an important reality which had to be dealt with in the agricultural economy of the Ivory Coast.

Regional Contribution to Export Agriculture, 1950-1958

In 1950, 39,700 metric tons of coffee were produced in the forested region. The ratio of this quantity to the total quantity of coffee exported that year from the Ivory Coast was 0.73 (Table 2). The table also shows that the production of coffee from the forested zone as well as the region's share of country total coffee exports had a positive trend over the period 1950-58. In 1958 the level of production for coffee from the forested region reached 91,000 metric tons, which represented a ratio to the country coffee export of 0.81 that year.

Cocoa production experienced an absolute decline in quantity between 1950 and 1958. However, over the period the ratio of regional cocoa production to total country cocoa exports increased from 0.67 to 0.82, even though regional cocoa production exhibited some fluctuations (Table 2).

Banana production increased steadily over the 1950-58 period from 20,300 metric tons to 43,600 metric tons. The region's share of total banana exports increased until 1958 (Table 2).

For pineapple and palm oil, the ratios of production from the forested areas to the country total exports ranged from 98.0 to 14.9 and from 5.9 to 9.1, respectively, over the 1950-58 period. For a given commodity, the ratio of the regional quantity produced to the national quantity exported would indicate the extent to which the region contributes in generating agricultural export earnings. Therefore, a ratio which value is equal to 1.0 would mean that the national export of the given commodity is being exactly met by the regional production of this commodity. On the other hand, a ratio greater than 1.0 would imply that the regional crop production is in excess of the country crop export whereas a ratio smaller than 1.0 would mean that the regional commodity production is only providing a share of the national export. Hence the magnitude of the ratios pertaining to pineapple and palm oil suggests that the bulk of the pineapple and palm oil produced was being used either for domestic consumption or as inputs to the domestic pineapple canning, and oil and fat industries.

Because of lack of data on prices to producer for coffee, cocoa, bananas, pineapple and palm oil, the average export prices for these commodities were used to compute the potential values of the commodities from the forested region (Table 2). These export values would generally tend to over-estimate the actual values to producers in the forested region, since prices to producers are generally lower than export prices. However, as a rough approximation they provide some indication of the revenue generating capacity of the region.

Table 2 indicates that the potential value of coffee production for the region had a positive trend from 1950 to 1958. In 1950, coffee

production was valued at 4,890.3 million CFA francs (CFAF).⁵ By 1958, regional coffee production was valued at 15,190 million CFA francs. This represented a 211 percent increase over the 1950-1958 period.

The estimated 1958 regional export value of cocoa registered a decline, relative to the values of 1952, 1954 and 1956. Nevertheless, the 1958 estimated value of the region represented a 67 percent increase over the 1950 value (Table 2).

Estimated regional value of banana production showed a positive trend over the 1950-1958 period. In 1950 the estimated value amounted to 309.2 million CFAF, whereas in 1958 the value was 1,204.5 million CFAF. The value growth over the period represented a 289 percent increase (Table 2).

As far as pineapple and palm oil production are concerned, both commodities exhibited positive trends in estimated regional values from 1950 to 1958. In 1950 fresh fruits pineapple production had an estimated export value of 284.2 million CFAF. The 1958 estimated export value of this commodity represented a 71 percent increase over the 1950-58 period. Over the same period the estimated export value of palm oil production increased from 0.2 million CFAF in 1950 to 0.4 million CFAF in 1958, representing a 100 percent increase in nominal value.

Summary

Covering an area of 325,770 square kilometers, the Ivory Coast is differentiated by two basic agro-ecological zones of natural vegetation--the savannah region in the north and the densely forested zone in the south. According to the 1975 national census the country's

⁵At current exchange rate \$1.00 U.S. = 300 CFA francs (CFAF).

population was 6.7 million. The population was estimated to have reached 8.2 million by the end of 1980. The savannah region mainly lends itself to food crop farming activities, while the forested region is favorable to industrial and export crops production. The forested zone can be further subdivided into three subregions: (a) the Eastern Forested Region, (b) the Central Forested Region, and (c) the Western Forested Region. The Eastern and Central Forested Regions have persistently dominated national industrial and export crop productions over time. The economic base of the forested region as a whole has historically been closely associated with the plantation system involving crops such as cocoa, coffee, banana, pineapple and oil palm. Furthermore, dating back to the pre-independence era, growth in the agricultural sector of the forested zone has served as the cornerstone of national economic growth and development policy.

CHAPTER II PROBLEMATIC SITUATION AND STUDY OBJECTIVES

Problematic Situation: Overview

Since 1960, the Ivory Coast has undertaken major investment efforts in the area of agricultural diversification. Diversification policy guidelines and implementation mechanisms were developed and articulated in the 1971-75 and 1976-80 National Development Plans [38,39]. It is evident from national data for the 1960-80 period (Table 3) that under the diversification strategy, on the average, crops that were earmarked for emphasis in the forested region have been increasing their relative share of total agricultural production despite period-to-period fluctuations in output shares. Quantity-wise, total agricultural production for the seven major industrial and export crops increased at an average rate of 6.6 percent per annum over the 1960-80 period (Table 3). Quantities of pioneering crops, such as coffee and cocoa, increased at average annual rates of 3.4 and 8.3 percent, respectively, over the period. On the other hand, output of coconut, banana, pineapple and oil palm (bunch) increased at average annual rates of 12.4, 3.1, 14.3 and 6.6 percent, respectively, over the same period. However, coffee and cocoa combined still represented 30.4 percent of the total quantity of the seven major industrial cash crops in 1980 compared to their combined relative share of 35.3 percent in 1960 (Table 3). This table also indicates that output shares experienced to some extent period-to-period fluctuations for the selected years over the 1960-80 period. Indeed, in 6 of the 11 selected years coffee and oil palm output shares were lower

Table 3. Production of major industrial and export cash crops grown mainly in the forested region, Ivory Coast, selected years, 1960-1980

Commodities	1960	1962	1964	1966	1968	1970	1972	1974	1976	1978	1980
	metric tons										
Coffee	136,635 (21.7) ^a	116,813 (17.6)	240,946 (28.2)	256,225 (26.6)	267,592 (26.0)	274,530 (22.3)	283,242 (17.6)	198,854 (11.0)	319,683 (16.0)	196,360 (9.7)	267,013 (11.8)
Cocoa	85,685 (13.6)	91,565 (13.8)	113,669 (13.3)	162,917 (17.0)	141,485 (13.7)	167,989 (13.6)	199,576 (12.4)	222,676 (12.3)	257,444 (12.9)	341,674 (16.9)	420,872 (18.6)
Banana	88,000 (14.0)	131,000 (19.8)	126,000 (14.8)	154,500 (16.0)	174,648 (17.0)	178,852 (14.5)	212,288 (13.2)	207,824 (11.5)	147,190 (7.3)	196,773 (9.7)	162,651 (7.2)
Oil palm (bunch)	296,121 (47.3)	297,424 (45.0)	327,339 (38.3)	318,400 (33.1)	341,117 (33.2)	480,181 (39.0)	686,544 (42.6)	916,102 (50.8)	973,820 (48.6)	926,000 (45.1)	1,079,656 (47.7)
Copra	2,000 (.03)	2,350 (0.4)	3,100 (0.4)	4,400 (0.5)	7,500 (0.7)	10,300 (0.8)	11,500 (0.7)	13,500 (0.7)	20,900 (1.0)	25,677 (1.3)	20,622 (0.9) ^b
Pineapple	19,805 (3.1)	22,777 (3.4)	41,184 (4.8)	60,840 (6.3)	89,424 (8.7)	109,605 (8.9)	202,699 (12.6)	228,131 (12.7)	267,491 (13.4)	319,735 (15.8)	289,780 (13.0) ^c
Rubber	0 (-)	205 (0.2)	2,045 (0.4)	4,959 (0.5)	6,870 (0.7)	11,041 (0.9)	14,536 (0.9)	16,511 (1.0)	16,852 (0.8)	18,704 (0.9)	21,626 (0.9)
Total	630,326 (100.0)	662,434 (100.0)	854,283 (100.0)	962,241 (100.0)	1,028,636 (100.0)	1,232,498 (100.0)	1,610,385 (100.0)	1,803,598 (100.0)	2,003,380 (100.0)	2,024,923 (100.0)	2,262,220 (100.0)

^aNumbers in parentheses are percentages of the total in a specific year.

^bEstimates based on the assumption that one coconut yields on average 180 grams of copra.

^cThe 1980 pineapple production for the domestic pineapple juice and slices industry was not available, it was therefore assumed that this production remained at its 1979 level.

Source: [22,23,24,25,26,34,35].

than those of 1960. For cocoa and banana, in 5 of the 11 selected years output shares were lower or equal to their 1960 counterparts.

Table 4 shows the value share of each of the seven crops as revenue generator to farmers over the 1960-80 period. In 1960, revenue generated to farmers from coffee represented 55.5 percent of the total revenue from the seven export cash crops. By 1980 this share was 33.1 percent, a relative decline of 22.4 percent. Revenue produced by cocoa amounted to 32.0 percent of the total proceeds from the seven crops in 1960, but was 52.2 percent in 1980. Coffee and cocoa revenues grew at average annual rates of 9.3 and 15.0 percent, respectively, over the 1960-80 period [22,26,34]. Although revenues generated by pineapple, coconut and oil palm grew at much higher rates (19.5, 16.2 and 13.0 percent, respectively), their relative shares in the total revenue generated by the seven crops were still relatively small in 1980 (Table 4). Of the five remaining crops, pineapple and rubber were the only two crops that showed significant increases in agricultural revenue shares over the 1960-80 period. An interesting dimension of Table 4 is the implication of the trend in relative revenue shares to producers of farm commodities. After more than a decade of export agriculture diversification efforts, the combined relative share of coffee and cocoa among the seven major export crops was only reduced from 87.5 percent in 1960 to 85.3 percent in 1980. These two crops accounted for a combined average share of 83.3 percent of producer export crops revenues over the 1960-80 period. The combined relative share of the five remaining crops only increased from 12.5 percent in 1960 to 14.7 percent in 1980. These five remaining crops accounted for a combined average share of 16.7 percent over the 1960-80 period.

Table 4. Trends and allocation of the revenue to producers of the main industrial and export crops primarily grown in the forested zone, Ivory Coast, selected years, 1960-1980

Commodities	1960	1962	1964	1966	1968	1970	1972	1974	1976	1978	1980
	million CFA francs										
Coffee	13,508 (55.5) ^a	9,113 (43.1)	22,167 (62.7)	19,992 (54.3)	24,895 (60.8)	26,946 (54.5)	30,145 (51.3)	24,993 (32.0)	49,158 (42.8)	49,090 (29.8)	80,104 (33.1)
Cocoa	7,797 (32.0)	6,043 (23.6)	8,184 (23.1)	11,331 (30.8)	10,452 (25.0)	14,222 (26.6)	17,647 (30.0)	34,684 (44.4)	45,826 (39.9)	85,418 (52.0)	126,262 (52.2)
Banana	1,743 (7.2)	2,052 (11.0)	3,168 (9.0)	3,023 (8.2)	2,705 (6.6)	3,716 (7.6)	4,514 (7.7)	4,961 (6.3)	4,307 (3.7)	6,077 (3.7)	7,517 (3.1)
Oil palm (tunch)	941 (3.9)	949 (5.1)	1,067 (3.0)	1,079 (3.0)	1,189 (3.0)	1,792 (3.6)	2,571 (4.4)	6,961 (8.9)	7,459 (6.5)	8,760 (5.3)	10,797 (4.5)
Copra	66 (0.3)	71 (0.4)	103 (0.3)	127 (0.3)	233 (0.5)	310 (0.6)	380 (0.6)	667 (0.9)	1,355 (1.2)	1,644 (1.0)	1,320 ^b (0.5)
Pineapple	268 (1.1)	308 (1.7)	466 (1.3)	717 (2.0)	950 (0.3)	1,538 (3.1)	2,649 (4.5)	3,325 (4.3)	3,960 (3.4)	9,439 (5.7)	9,431 ^c (4.0)
Rubber	--	18 (0.1)	200 (0.6)	517 (1.4)	528 (1.3)	900 (1.8)	866 (1.5)	2,477 (3.2)	2,848 (2.5)	4,171 (2.5)	6,250 (2.6)
Total	24,323 (100.0)	18,554 (100.0)	35,355 (100.0)	36,786 (100.0)	40,952 (100.0)	49,424 (100.0)	58,792 (100.0)	78,068 (100.0)	114,913 (100.0)	164,459 (100.0)	241,681 (100.0)

^aNumbers in parentheses are percentages of the total in a specific year.

^bEstimates based on the assumption that one coconut yields on average 180 grams of copra.

^cThe 1980 pineapple production for the domestic pineapple Juice and slices industry was not available, it was therefore assumed that this production remained at its 1979 level.

Source: [22,23,24,25,26,34,35].

Figure 4 illustrates the trends in nominal CFA franc value of agricultural earnings to farmers for the seven selected industrial cash crops grown primarily in the forested region over the 1960-80 period. Generally, the trends for these crops were positive over the period. However, revenues to coffee producers showed comparatively sharper swings at higher levels. The lowest level of agricultural earnings from coffee for the selected years amounted to 9,113 million CFA francs in 1962. From 1962 to 1980, cocoa earnings grew at an active and positive pace. Specifically, cocoa earnings grew by about 69.0 percent from 1968 to 1972, and 615.5 percent from 1972 to 1980. On the other hand, coffee earnings grew by 21.1 percent and 165.7 percent over the 1968-72 and 1968-80 periods respectively.

Producer revenues from oil palm appear to have grown more rapidly than those from banana, pineapple and coconut (copra). Earnings from copra grew by 92.4 percent between 1960 and 1966, then increased at an annual rate of 18.2 percent over the 1966-80 period. From 1960 to 1968, earnings to farmers from banana grew by 55.2 percent, whereas the increase was 178.0 percent over the 1968-80 period. In the case of pineapple, producer earnings grew by 254.5 percent from 1960 to 1968, and then grew at an annual rate of 21.1 percent over the 1968-80 period. Earnings generated by oil palm grew by about 26.4 percent between 1960 and 1968, and 808.1 percent over the 1968-80 period, which translates into an annual growth rate of 20.2 percent. Earnings from natural rubber grew at an annual rate of about 65.0 percent from 1961 to 1970, then declined to 21.4 percent per annum over the 1970-80 period (Figure 4).

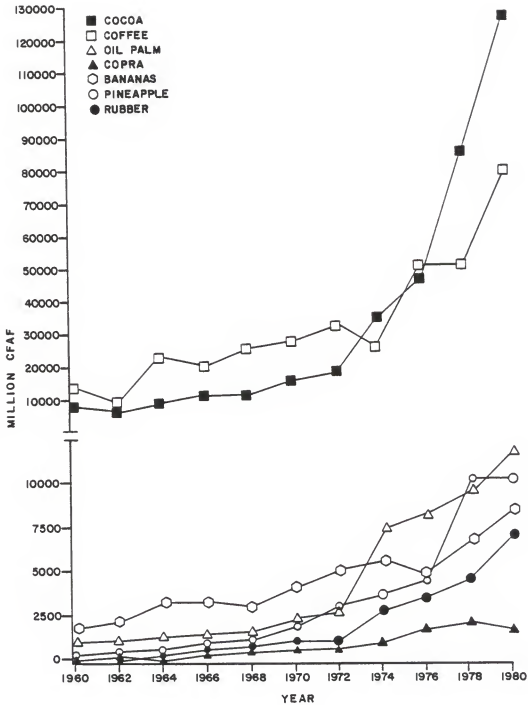


Figure 4. Trends in earnings to producers of the major crops grown in the forested zone, Ivory Coast, selected years, 1960-1980

Although earnings from coffee and cocoa showed relatively high positive trends for selected years over the 1960-80 period (Figure 4), they also exhibited a higher degree of year-to-year fluctuations at higher levels for the period, relative to the other five export crops (Figure 5). Given that earnings from the remaining crops only represent a relatively small share of the total agricultural earnings generated, this situation would suggest that a larger share of the producer income in the forested region was vulnerable to wide year-to-year fluctuations as a result of coffee and cocoa earnings instability over the 1960-80 period. This was particularly true for coffee earnings. Specifically, coffee earnings averaged about 48.0 percent of the yearly earnings from the seven crops over the period. The erratic behavior of the coffee earnings appeared to be highly correlated to variations in quantity, as suggested in Figures 4, 5, and 6. Thus, as quantity fluctuated from year to year, this generated fluctuations in aggregate coffee revenues and total revenues from the seven crops.

The seemingly quantity-induced nature of coffee, and to a lesser degree cocoa earnings variability, suggests that there might have been structural problems on the supply side that were not fully addressed by the "demand oriented" stabilization policy of Ivorian agricultural diversification programs. Interestingly, Figures 4, 5, and 6 show that although the quantity of coffee produced abruptly declined 38.6 percent from 1976 to 1978, the aggregate earnings to coffee producers remained constant over the 1976-78 period. This is an indication that there was an increase in the average price paid to coffee producers over the 1976-77 period in order to compensate for the drastic decline in coffee production. The National Stabilization Fund (Caisse de Stabilisation et

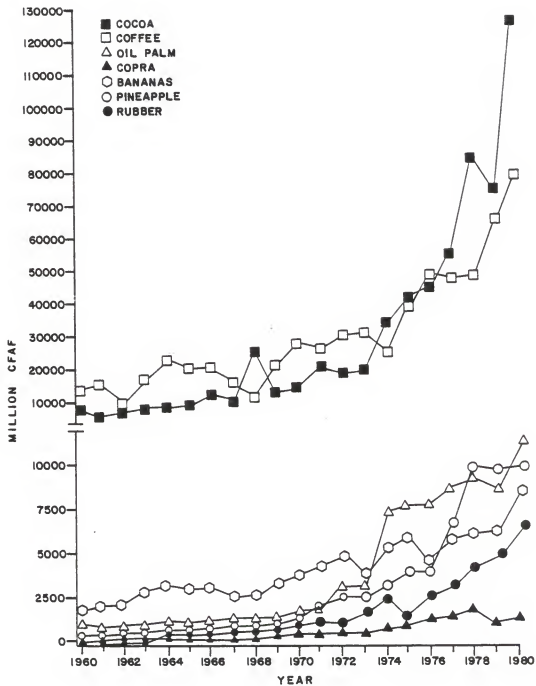


Figure 5. Trends in yearly earnings to producers of the major crops grown in the forested zone, Ivory Coast, 1960-1980

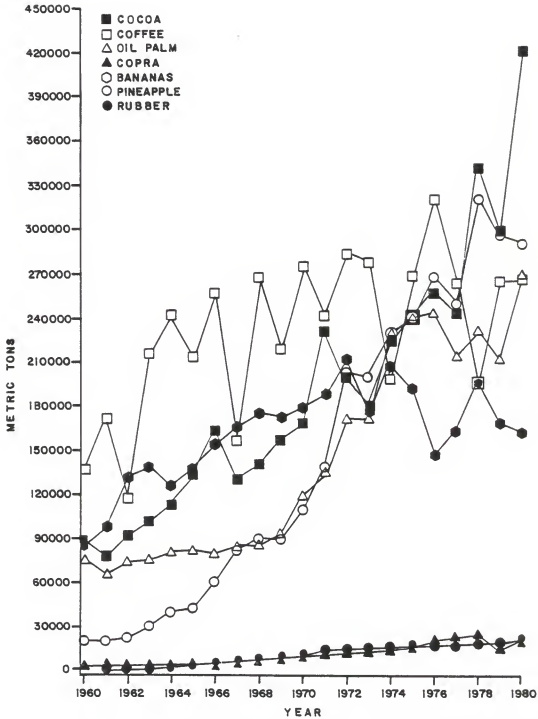


Figure 6. Trends in production of the major crops grown in the forested zone, Ivory Coast, 1960-1980

de Soutien des Prix des Productions Agricoles) has been used as a pricing mechanism to counter earnings instability and welfare losses to farmers growing the industrial and export cash crops. It is recognized that widely variable incomes to such producers could affect aggregate consumption and investment decisions and ultimately result in unplanned resource allocation. The accumulated stabilization reserves have historically been large enough not only to ensure producers of selected crops relatively stable and increasing prices, but also to facilitate the extension of financial capital by the public sector for investments in regional and national development projects.

It is clear that some degree of export crop diversification has been achieved for the forested region, in terms of a greater crop mix (Table 4). However, for the 1960-80 period there is strong evidence that the diversification programs have not significantly altered the dominance of coffee and cocoa in the economies of the forested region and the nation (Tables 4 and 5). Of the producer earnings generated by the seven industrial and export crops grown primarily in the forested region, coffee and cocoa accounted for a combined share of 87.5 and 85.3 percent in 1960 and 1980, respectively (Table 4). Nationally, coffee and cocoa combined revenue shares of total agricultural export earnings were about 65 percent and 66.5 percent in 1960 and 1978, respectively (Table 5).

In the final analysis, data indicate a persistently high level of specialization in coffee and cocoa production in the forested zone after more than a decade of vigorous diversification programs in the region. In light of this fact, one would hypothesize that ceteris paribus, forested zone agricultural producers have gained significantly higher

Table 5. Share of export commodities as percentage of total agricultural export earnings, Ivory Coast, selected years, 1952-1978

Commodities	1952	1954	1956	1958	1960	1962	1964	1966	1968	1970	1972	1974	1976	1978
-----percent-----														
Coffee	56.4	60.4	57.5	59.6	45.0	37.4	42.0	36.1	35.0	35.0	28.6	25.4	34.9	27.2
Cocoa	32.8	32.3	32.0	20.4	19.7	20.5	17.7	14.7	18.0	18.0	15.6	30.2	23.6	39.3
Timber	3.3	3.7	4.8	10.5	13.6	16.3	20.0	19.0	19.4	17.0	21.2	26.4	20.2	13.8
Sub total	92.5	96.4	94.3	90.5	78.3	74.2	79.7	69.8	72.4	70.0	65.4	82.0	78.7	80.3
Banana	1.7	1.2	1.3	4.0	5.1	5.8	5.1	6.0	4.0	4.0	4.2	1.5	0.8	0.8
Palm oils a kernel	0.9	0.8	1.2	1.2	--	--	--	--	--	--	--	8.0	2.0	2.0
Colanuts	--	--	--	--	4.0	3.0	1.9	2.1	12.2	1.7	0.6	0.6	0.2	0.2
Pineapple	--	--	--	--	0.2	0.2	0.2	0.4	0.5	1.0	1.5	4.1	2.7	2.6
Misc.	4.9	1.6	3.2	4.3	12.4	16.8	13.1	21.7	20.9	23.3	28.3	3.8	15.6	14.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: [22,33,34,36,40].

benefits from export crop specialization than from crop diversification. If this is indeed the case, it could be further hypothesized that those regions within the forested zone that have experienced a relatively high level of specialization in coffee and cocoa should have registered rapid income growth, relative to other regions that have diversified at an active pace away from these crops. Table 6 suggests preliminary evidence in support of the above hypotheses. The table shows that for the selected years 1965, 1975 and 1980 the Central Forested Region experienced the highest absolute per capita income in rural areas in 1975 and 1980. These high levels of per capita income were concomitant with the highest population growth rates among the three subregions over the 1965-75 and 1975-80 periods. With almost equally significant rural population growth rates over the same periods, the Eastern Forested Region, after generating the highest per capita income in 1965, experienced the second highest per capita incomes in the years 1975 and 1980. For the Western Forested Region, the population growth rates were relatively low, and this translates into comparatively high per capita income growth rates. In the Eastern and Central Forested Regions coffee and cocoa plantations have continued to dominate regional and national productions of these two industrial and export crops. The 1980 agricultural census indicated that the Eastern Forested Region accounted for 32.6 percent and 44.4 percent of national coffee and cocoa production, respectively, in 1980. On the other hand, the Central Forested Region provided 33.5 percent and 38.6 percent of the national coffee and cocoa production in 1980 (Table 1). It should be noted that most of the national pineapple and banana productions are from the Eastern Forested Region. For coconut (copra), oil palm (bunch) and

Table 6. Population and per capita income in rural areas of the forested subregions and nation, Ivory Coast, selected years, 1965-1980

Regions	Population		Annual rate of change		Per capita income in current CFA francs		Annual rate of change		Per capita income		Annual rate of change				
	1965	1975	1980	1965-75	1975-80	1965	1975	1980	1965-75	1975-80	1965-75	1975-80			
	-----persons-----	-----persons-----	-----persons-----	-----percent-----	-----percent-----	-----CFA francs-----	-----CFA francs-----	-----CFA francs-----	-----percent-----	-----percent-----	-----CFA francs-----	-----percent-----			
Eastern Forested	796,600	1,187,942	1,468,115	4.1	4.3	30,353	39,265	59,287	2.6	8.6	30,353	21,527	24,150	-3.4	2.3
Central Forested	605,400	922,962	1,149,202	4.3	4.5	20,497	42,177	75,168	7.5	12.3	20,497	23,124	30,619	1.2	5.8
Western Forested	585,800	696,665	769,636	1.7	2.0	11,543	18,263	44,247	4.7	19.4	11,543	10,013	18,024	-1.4	12.5
Country ^a	4,510,000	6,702,866	8,122,255	4.0	4.0	48,570	114,353	210,338	9.0	13.0	48,570	62,148	70,821	2.5	2.6

^aThe country population was estimated based on the assumption that the population grew at its 1965-75 average annual growth rate over the 1965-1980 period. Given data on the country's population in 1975 and 1980, the population in 1965 was estimated to be 4,510,000. The per capita income in 1965 was estimated to be 48,570 CFA francs. The 1978 price index was used to estimate the 1980 country per capita income in constant 1965 CFA francs. The indices used were 182.4, 245.5 for the rural area and 184, 297 for the whole country in 1975 and 1980, respectively.

Source: [4, 27, 32].

natural rubber, the Eastern Forested Region accounted for 91.5, 75.9 and 98.1 percent of production, respectively, in 1980, whereas the relative shares of the Central Forested Region for the same crops were 6.3, 8.6 and 0 percent, respectively, in 1980. As far as the Western Forested Region is concerned, it provided 20, 5.3, 2.2, 14.4 and 1.9 percent of the national coffee, cocoa, coconut, oil palm and rubber production, respectively, in 1980 (Table 1). Table 6 further illustrates that the smallest annual rate of change in the per capita income in the subregions was 2.6 percent experienced in the Eastern Forested Region, compared to 7.5 percent and 4.7 percent in the Central Forested Region and the Western Forested Region, respectively, over the 1965-75 period. Actually, the 2.6 percent and 4.7 percent rates of growth for the Eastern Forested Region and Western Forested Region, respectively, translated into annual rates of declines of 3.4 percent and 1.4 percent in their per capita income in constant 1965 CFA francs over the 1965-75 period. However, over the 1975-80 period, both subregions experienced positive growth rates in the per capita income in both current and constant CFA francs. On the other hand, the Central Forested Region experienced positive growth rates in its per capita income in both current and constant CFA francs over the 1965-75 and 1975-80 periods. Table 6 also indicates that, although the 1980 per capita income in the Western Forested Region was lower than its counterparts in the Eastern and Central Forested Regions, the region experienced the highest per capita income growth rate in both current and constant CFA francs over the 1975-80 period. This suggests that the overall agricultural and subsistence income in the Western Forested Region grew at a much higher rate than its rural population. Also, from Table 6 it would appear that

the increase in per capita income in rural areas of the Central Forested Region was associated with some degree of specialization in coffee and cocoa, relative to the two other subregions, over the 1965-80 period.

Per capita income, coffee, cocoa, coconut, oil palm and natural rubber production trends in the Eastern Forested Region could suggest that this region, as the historical coffee and cocoa producing area, has developed a relatively high degree of technical know-how in the production of these commodities. As such, this technical know-how could have enabled the region to grow these crops more efficiently. Such efficiency, if it really existed for coffee and cocoa production, could also have reduced some of the risks that would normally confront coffee and cocoa growers who successfully undertook cultivation of many of the crops involved in the diversification programs (Tables 1 and 6). Such a subperiod level of crop mix enjoyed by the Eastern Forested Region relative to the Central and Western Forested Regions, could have in turn resulted not only in lower per capita income levels in the region vis-a-vis the Central Forested Region in 1975 and 1980, but also in smaller per capita income growth rates in the Eastern Forested Region with respect to its counterparts in both the Central and Western Forested Regions over the 1965-76 and 1975-80 periods (Table 6). The long-term implication of income benefits in favor of commodity specialization could pose serious developmental problems for the Ivorian agricultural and national economies. Those developmental problems would arise from the existence of growth and development patterns that are running counter to the long-term developmental pattern based on an agricultural diversification strategy. It is important, therefore, to understand the direct and indirect impacts of Ivorian agricultural

diversification programs on important development parameters in order to determine if the programs are accomplishing intended national objectives.

Study Objectives

The general objective of the study is to determine the income distributional impacts of Ivorian export crop diversification programs on subregions of the forested zone, and to assess the extent to which these impacts are consistent with the long-term objective of producer and consumer welfare gains within the region and the nation.

Specific objectives of the study are to:

Objective 1: (a) Analyze and quantify the degree of diversification or specialization exhibited among major industrial and export cash crops in the forested region in general, and its subregions in particular, and (b) Identify the trends of the diversification (or specialization) patterns among the same crops and regions from 1960 to 1980.

Objective 2: Determine and evaluate the impact of the export and industrial crop mixture under diversification on producer agricultural earnings within subregions of the forested zone.

Objective 3: (a) Evaluate the effect of export and industrial cash crop specialization and diversification trends on the export earnings stability of the forested zone and its subregions, and (b) Evaluate crop-associated earnings diversification on year-to-year earning variability among regions.

Objective 4: Determine the extent to which the trends exhibited in the agricultural economy of the forested region under national diversification programs are consistent with national objectives of

structural transformation of the agricultural economy, as well as national and regional growth, development and equity considerations.

Summary

The Ivory Coast has undertaken important investment efforts for agricultural crop diversification since 1960. National diversification policy guidelines and implementation mechanisms were articulated in the 1971-75 and 1976-80 Development Plans. Although the new crops emphasized in the diversification programs have been increasing their relative shares in both total agricultural output and earnings, nevertheless, coffee and cocoa combined still represented 30.4 and 85.3 percent of the total quantity and earnings, respectively, of the seven major export crops in 1980. Earnings from coffee and cocoa showed very high positive trends over the 1960-80 period. However, the positive trends were vulnerable to comparatively severe year-to-year quantity induced fluctuations. Preliminary data analysis suggests a persistently high level of specialization in coffee and cocoa production after more than a decade of vigorous diversification programs in the Forested Zone. Eastern and central forested regions' coffee and cocoa plantations have continuously dominated regional and national production of these two export crops. However, it is hypothesized that the current per capita income level in the central forested subregion might be associated with a relatively high degree of export crop specialization, whereas its counterpart in the eastern forested subregion might be associated with an advanced degree of export crop diversification. The four specific objectives of the study are (a) Quantification and analysis of the degree and patterns of crop diversification, (b) determination of the impact of crop diversification on producer earnings stability, (c)

evaluation of the effects of crop diversification trends on producer earnings stability, and (d) determination of the extent to which the historical economic trends are consistent with national objectives of structural transformation of the agricultural economy as well as national developmental and equity objectives of the country.

CHAPTER III
EVOLUTION AND CHARACTERISTICS OF IVORIAN
AGRICULTURAL DIVERSIFICATION PROGRAMS

The 1960-70 Diversification Program

In 1960, 78.3 percent of the total value of agricultural export earnings of the Ivory Coast was accounted for by three commodities, coffee, cocoa and timber (Table 5). The 1960-70 Development Plan of the Ministry of Planning [37] spelled out the dangers of having the national economy based on the fate of these three commodities. It was argued that this dependence made the economy an easy target for commodity price fluctuations in international markets. As a result, the need to diversify cash crops was accorded high priority over the planning period. The goal of the agricultural diversification policy was to allocate the relative weights of agricultural export earnings to a greater number of commodities. In short, structural changes in the base of the agricultural export subsector was given high priority. The plan also called for creation of domestic agricultural processing facilities. Among commodities programmed to play new and significant roles in the diversification program were palm oil and kernels, banana, pineapple, cotton, tobacco and rubber [1].

The slack world demand and low prices for coffee and cocoa in the early 1960s provided additional impetus to diversification programs in the forested region. Only under the agro-ecological conditions prevailing in the forested zone (the South) could targeted enterprises such as banana, rubber, coconut, pineapple, palm oil and kernel be grown

successfully. In addition, significant hectareage of arable land was readily available in that region, particularly in the Western Forested Region. This situation led to continued concentration of agricultural activities and further attention of the agricultural policy makers on the forested region. In the case of palm oil, a special statutory agency, SODEPALM⁶ was created to implement the developmental program for that commodity.

During the 1960s, cotton production also became economically feasible in the Northern Savannah Region (Figure 2) with the introduction of the high yielding variety (Allen), and the pest control programs of CFDT.⁷ The ecological conditions in the Northern Savannah Region are well suited for cotton production but production was not economically feasible under earlier technology. At the present time, this commodity is increasingly grown in rotation with food crops. The introduction of ox-drawn cultivation in the region has significantly improved the farming system. The new farming techniques are expected to be factors in facilitating the integration of the northern region into the general economy, as well as closing the income gap between the North and the South.

The 1971-75 Diversification Program

The 1971-75 Development Plan [38] was the first planning document to articulate comprehensive policy goals and program guidelines for

⁶SODEPALM is acronym for Société pour le Développement et l'Exploitation du Palmier à Huile (Oil Palm Development Company). SODEPALM subsequently was assigned sponsorship of the coconut palm program.

⁷CFDT is acronym for Compagnie Française pour le Développement des Textiles (French Textile Development Company). In the mid-1970s CFDT became CIDT acronym for Compagnie Ivoirienne pour le Développement des Textiles (Ivorian Textile Development Company).

meeting agricultural diversification and developmental objectives for Ivorian Agriculture. Although the plan dealt with a wide spectrum of crops, only those that are relevant to this study are reviewed.

Coffee

According to the 1971-75 plan, coffee production was targeted for 1975 at 260,000 metric tons [38]. Varieties developed by the French Institute for Coffee and Cocoa (IFCC)⁸ were to be utilized in two types of planting programs to meet this objective. The projected planting schedules of the two programs are given in Table 7. One program (Program A) consisted of modern type of coffee plantations which would utilize modern intensive farming practices. In this program, yield per hectare was projected to be 700 kilograms for the first year of production, which is actually three years after the planting year. Program A was then projected to yield 100, 1300 and 1500 kilograms per hectare for the fourth, fifth and sixth years, respectively, after planting. The second program (Program B) consisted of plantations in which a mixture of traditional and modern farming methods were to be used. The projected yield for Program B type plantations was 200, 550 and 700 kilograms per hectare for the third, fourth and fifth years, respectively, after planting. An improved variety had been developed by IFCC for this program.

Under the planting schedules established in Table 7 there was to be a major substitution of improved coffee. Under this programming schedule it was projected that by 1975-76 traditional coffee farms would have been completely phased out. Table 8 indicates the steps outlined

⁸IFCC is acronym for Institute Francais pour le Cafe et le Cacao (French Institute for Coffee and Cocoa).

Table 7. Projected schedules in the planting of the two different varieties of coffee, Ivory Coast, 1969-70 through 1979-80

Years	Traditional Varieties (Unimproved)	Hybrid Varieties		Total
		Program A	Program B	
-----hectares-----				
1969-70	20,000	--	1,000	21,000
1970-71	13,000	500	6,500	20,000
1971-72	9,000	1,000	9,000	19,000
1972-73	4,000	2,000	15,000	20,000
1973-74	4,000	2,000	15,000	21,500
1974-75	4,000	2,500	15,000	21,000
1975-76	--	2,500	15,000	17,500
1976-77	--	2,500	15,000	17,500
1977-78	--	2,500	15,000	17,500
1978-79	--	2,500	15,000	17,500
1979-80	--	2,500	15,000	17,500

Source: [33].

for implementing the two programs over selected periods. The distribution of improved nursery stocks was assigned to SATMACI,⁹ the state agency responsible for modernizing Ivorian agriculture. The southwest forested region was designated as the target production region for Program A coffee plantations. The estimates for investment and other financial expenditures associated with the programs for coffee were then projected to be 2,152 million CFAF for the 1971-75 period and 2,306 million CFAF for the 1976-80 period [38].

The targeted coffee production level for 1975 was exceeded. The 1975 Agricultural Census indicates that for the crop year 1974-75, 270,400 metric tons of coffee were produced and marketed within the country [22]. This was 12,000 metric tons in excess of the 1975 targeted output (Table 8). However, data in the 1980 Agricultural Census show that coffee production for the 1979-80 crop year was 249,600 metric tons, which translates into 54,000 metric tons short of the targeted production level for 1980 (Table 8). An interesting aspect of this situation is that the targeted output level for 1980 was exceeded during the 1975-76 crop year, when 308,400 metric tons of coffee were produced and marketed [23].

Cocoa

Cocoa consistently ranked second to coffee in terms of the quantity and value to producers of export crops up until 1973, after which period the pattern changed drastically (Figures 4, 5, and Table A-1). About 481,700 hectares were under cocoa cultivation in 1969-70. Ministry of

⁹SATMACI is acronym for Société d'Assistance Technique pour la Modernisation de l'Agriculture en Côte d'Ivoire (Technical Assistance Company for the Agricultural Modernization of the Ivory Coast).

Table 8. Projected coffee planting under production programs, Ivory Coast, selected periods, 1969-70 through 1979-80

Crop years	Type of plantation	Area planted	Area in production	Average yield per hectare	-----hectares-----		-----metric tons-----	
							Production of the crop year	Production of the calendar year
1969-1970	Traditional	780,000	720,000	.332			239,000	(1970) 240,000 ^a
	Modern	--	--	--			--	--
	Program A	1,000	--	--			--	--
	Program B	781,000	720,000	.332			239,000	(1970) 240,000
1974-1975	Total							
	Traditional	796,000	784,000	.320			251,000	(1975) 251,500
	Modern							
	Program A	7,500	1,500	.800			1,200	(1975) 1,500
1979-1980	Program B	61,500	16,000	.370			6,100	(1975) 7,000
	Total	865,000	802,000	.322			258,400	(1975) 260,000
	Traditional	746,000	746,000	.314			234,300	(1980) 234,300
	Modern							
	Program A	20,000	12,500	1.200			15,000	(1980) 15,500
	Program B	135,000	91,500	.593			54,300	(1980) 15,500
	Total	901,500	850,000	.357			303,600	(1980) 305,000

^aFigures in parentheses are calendar years.

Source: [38].

Agriculture data for this period indicate that 47.3 percent of the area under cocoa cultivation was below 15 years of age [38]. However, it should be noted that with the then prevailing state of technology, a cocoa tree would reach the maximum yield between 11 and 13 years of age. After this age, yield would constantly decline until the tree is 40 or 45 years old, at which time the yield is negligible.

The aggressive program for cocoa regeneration undertaken beginning in the 1960s, under the direction of SATMACI, was able to increase the average cocoa yield per hectare from 300 to 700 kilograms. The 1971-75 program for regenerating cocoa trees had as one objective the bringing of 60 percent of the targeted cocoa hectareage under cultivation by the year 1975 [38]. It was projected that traditional and modern plantations would produce at levels indicated in Table 9 over the 1969-80 period.

The French Institute for Coffee and Cocoa (IFCC) had developed a hybrid cocoa variety that was able to produce fruits 3 years after planting, and under favorable conditions yield an average of 2500 kilograms per hectare at 6 years of age. Table 9 shows how the cocoa regenerating and production programs were expected to evolve over the 1969-80 period under the diversification plan. According to the plan [38] hybrid cocoa plantations were to cover about 86,500 hectares over the 1971-75 period and 84,750 hectares for the 1976-80 period. The regional allocation of the hectareage over the 1971-75 period was as follows:

Southwestern region:	36,750 hectares
Western region:	13,450 hectares
Mid-western region:	11,350 hectares

Table 9. Projected cocoa planting under production program, Ivory Coast, selected periods, 1969-70 through 1979-80

Crop year	Type of plantation	Area planted	Area under production	Production per crop year	Production ^a per calendar year
		-----hectares-----		-----metric tons-----	
1969-70	Traditional	481,695	373,295	168,000	
	Modern	5,600	--	--	
	Total	487,295	373,295	168,000	(1970) 175,000
1974-75	Traditional	486,330	428,830	209,000	
	Modern	92,080	26,940	9,000	
	Total	578,410	455,770	218,000	(1975) 230,000
1979-80	Traditional	459,080	449,780	228,000	
	Modern	176,830	129,730	114,000	
	Total	635,910	579,510	342,000	(1980) 365,000

^aFigures in parentheses are calendar years.

Source [38].

Southern region:	14,850 hectares
Other regions:	10,080 hectares

The pattern of this allocation clearly indicates that the southwest was to benefit from the largest share of the hectarage for new cocoa farms over the 1971-75 period. This allocation was intended to exploit the natural potential of the southwest for growing export or domestic cash crops. Given the projected output from the regeneration program and the expected output from the regeneration program and the expected output from existing plantations, it was estimated that total production of 175,000, 230,000 and 365,000 metric tons could be expected for the years 1970, 1975 and 1980, respectively. Data indicate that the 1975 production target was exceeded by 9,400 tons while the 1980 target was exceeded by almost 56,000 tons (Table A-6).

As in the case of coffee, IFCC and SATMACI were to share the research and extension responsibilities associated with cocoa expansion. SATMACI was to facilitate the conditions for cocoa planters to secure loans for purchasing fertilizer and pesticides associated with cocoa production. The plan argued that, with the expected increase in average cocoa yields, cocoa farmers' revenue at the farm gate would rise from 14 billion CFAF in 1970 to 18.4 billion CFAF in 1975, and 29.2 billion CFAF in 1980 [38].

Banana

Banana was one of the original cash crops incorporated into the 1960-70 agricultural diversification program. In order to meet the fierce competition from Latin American countries, the industry was targeted for higher productivity levels and improvement in packaging. The long-run objectives were, among other things, to increase Ivorian

market share in countries such as France, Italy and Algeria, and to penetrate new markets.

Table 10 shows how the targeted production of banana and revenues to producers was expected to evolve up to 1980. In order to reduce transportation costs the program called for major regional shifts in banana production. Future banana plantations were only scheduled for development in the vicinities of ports [38]. The agency SODEFEL¹⁰ was assigned the responsibility of training and advising banana farmers. It would appear that the production targets for 1975 and 1980 were not realized. The 1975 target had a shortfall of about 8,700 metric tons, while that of 1980 was about 66,300 tons (Tables 10 and A-6).

Pineapple

Commercial production of pineapple began in the 1950s, and coincided with a period of very favorable commodity prices in the franc currency zone. In 1963, France moved to a policy of freer trade whereby the hitherto protected market for pineapple registered significant price declines. The price declines for fresh fruits were partially compensated by improvement in yields and extension of the processing capacities of the existing plants. Under these adjustment strategies the bulk of Ivorian production would still be sold on the French market, while residual pineapple exports were to be sold to other EEC member countries, where tougher competition was anticipated from the Philippines and Taiwan.

Table 11 shows the projected growth of pineapple production and producer revenues over the 1965-1980 period. According to the table,

¹⁰SODEFEL is acronym for Société de Développement des Fruits et Légumes (Fruits and Legumes Development Company).

Table 10. Projected banana production, exports, domestic consumption and value to producers, Ivory Coast, selected years, 1965-1980

Years	Exports	Losses ^a	Domestic consumption	Total production	Value to producers ^b
	-----metric tons-----		-----million CFAF-----		
1965	105,000 ^c	45,000	10,000	160,000	3,200.0
1970	130,000	52,500	11,000	193,500	3,870.0
1975	143,000	46,000	12,000	201,000	4,020.0
1980	164,000	52,000	13,000	229,000	4,580.0

^aLosses include grade rejects and damaged fruits.

^bValue to producer estimated at an average of 20,000 CFA francs per metric ton.

^cBananas are exported in cardboard packages, except in 1965 when fruits were exported in bunches.

Source: [38].

Table 11. Projected pineapple productions, exports, domestic consumption and values, Ivory Coast, 1965-1980

Item	1965	1970	1975	1980	1965	1970	1975	1980
	-----thousand metric tons----				-----million CFA francs ^a -----			
Pineapple fruits for canning by domestic processing industry	31.6	120.0	175.0	220.0	221.0	840.0	1,225.0	1,540.0
Pineapple fruits for export unprocessed	6.4	15.0	40.0	80.0	224.0	525.0	1,400.0	2,800.0
Pineapple fruits for domestic consumption	6.0	7.0	8.0	9.0	42.0	49.0	56.0	63.0
Total	44.0	142.0	223.0	309.0	487.0	1,414.0	2,681.0	4,403.0

^aValues of pineapple for canning and pineapple fruits for domestic consumption were estimated at CFAF 7000 per metric ton whereas the value of pineapple fruits for export was estimated at CFAF 35000 per metric ton.

Source: [38].

the projected relative share of production for domestic processing and canning was to increase about seven-fold over the 1965-1980 period. The amount of projected unprocessed pineapple exports in 1980 would be 12.5 times the 1965 level. Total revenue to pineapple producers was estimated to increase from 1,414 to 4,403 million CFA francs over the 1970-1980 period. A project aiming at development of pineapple plantations in the vicinities of Abidjan and Tiasslé in the Eastern Forested Region (Figure 3) was expected to bring 210, 420 and 420 additional hectares under pineapple cultivation for the years 1971, 1972 and 1973, respectively [38].

Oil Palm

According to the 1971-75 Plan, the 1970 production of the wild oil palm was projected to be 250,000 metric tons of palm bunches per year [38]. The oil palm development program of the early 1960s was aimed at the commercialization of selected hybrid varieties. Justification for such a program was dictated on one hand by the favorable prospect for palm oil and kernel in the international market, and on the other hand by a growing demand for palm products (soap and oil) on the domestic market.

IRHO¹¹ was assigned the responsibility for developing high yielding oil palm varieties. SODEPALM, the state company for the development of oil palm, was assigned responsible for national coordination of the oil palm program. SODEPALM was also mandated to be directly involved in establishing and administering industrial plantations and to facilitate

¹¹IRHO is the Institut de Recherches des Huiles et Oléagineux (Institute for Research on Edible Oils and Oleaginous Products).

the development of villager-owned plantations. The Plan called for the development of 12 industrial blocks of plantations over the 1970-71 period. Nine of these blocks were to be located in the south and the remaining 3 blocks in the southwest as dictated by economic conditions.

Table 12 indicates the programming sequence for the national oil palm scheme over the 1968-1980 period. The table shows that the share of planted hectareage of oil palm plantation under SODEPALM control was to triple over the 1968-80 period. On the other hand, the share of the villager owned plantations was to increase from 12,460 to 58,120 hectares over the same period [38]. However, data in Table A-11 indicate that a total of 100,349 hectares of land were under oil palm cultivation in 1980. This includes industrial and villager plantations, as well as other privately owned plantations. The magnitude of the discrepancy between the projected and actual size of land earmarked for oil palm was due to the fact that the 1971-75 Plan was too ambitious, on one hand, and, on the other hand, to some financial problems experienced by SODEPALM to the extent that planting was drastically reduced in 1978 [46].

It was estimated that the total gross revenue accruing to growers would increase from CFAF 1,816 million in 1970 to CFAF 5,818 million in 1980, an increase of 220 percent. Village plantations owners' share of gross oil palm revenue was projected to increase from 9 percent in 1970 to 31 percent in 1980. The relative revenue shares accruing to industrial plantation blocks was projected to increase from 21 percent in 1975 to 45 percent in 1980 [38].

Table 12. Estimates and projected areas under oil palm cultivation, Ivory Coast, selected years, 1968-1980

Cultivations	1968	1969-70	1970	1971-75	1975	1976-80	1980
	-----hectares-----						
Areas Planted:							
Industrial Block Plantations	27,380	9,510	36,890	10,320	47,210	20,000	67,210
Villager Plantation	12,460	8,000	20,460	17,660	38,120	20,000	58,120
Total Under SODEPALM Administration	39,840	17,510	57,350	27,980	85,330	40,000	125,330
Other Private Plantations	10,470	530	11,000	280	11,280	--	11,280
Total	50,310	18,040	68,350	28,260	96,610	40,000	316,610

Areas in Production:							
Industrial Block Plantations	2,682		13,360		39,210		51,210
Villager Plantations	2,045		5,880		24,120		42,120
Total Under SODEPALM Administration	4,727		19,510		63,330		93,330
Other Private Plantations	7,950		9,000		11,280		11,280
Total	12,677		28,510		74,610		104,610

Source: [38].

Coconut Palm

Agro-ecological conditions are also favorable for commercial production of coconut palm in the Ivory Coast. The demand prospects for coconut products in the international oil and fat markets were projected to remain favorable in the short and long run. Moreover, a major justification for growing coconut was its contribution to the diversification of modern types of agricultural activities.

The Research Institute on Edible Oils and Oleaginous Products (IRHO) was successful in developing hybrid coconut palm varieties that would produce fruits as early as five years from planting. These hybrids were capable of producing an average yield of 3,200 kilograms of copra per hectare eight years after planting. As in the case of oil palm, the development program was based on SODEPALM owned industrial block plantations and villager owned plantations. The total area under coconut plantations was projected at 64,105 hectares in 1980, which represented an increase of 162.3 percent over the 1970 level. The projected evolution of coconut production and revenue to producers over the 1965-80 period, according to the 1971-75 Plan, indicates that the 1970 copra production (6,400 metric tons) was to come exclusively from villager owned plantations. The 1980 projection of 62,000 metric tons of copra were projected with almost equal tonnages coming from industrial plantations and from villager owned plantations [38]. Data from Table A-6 show that 15,800 metric tons of copra were produced in 1975. This represents 1,800 metric tons over the projected level. On the other hand, the table indicates that the 1980 copra production level was 20,622 metric tons, which translates into 41,378 metric tons short of the 1980 targeted output level [22,26].

Natural Rubber

Technological progress in the international rubber industry has further complicated demand forecasting for natural rubber. In spite of the demand uncertainties, planners felt the need to exploit the favorable ecological conditions for natural rubber production in the southern and southwestern regions of the forested zone. The Research Institute for Rubber (IRCA)¹² has developed a high yielding hybrid rubber plant. From the 10,000 hectares in 1970, the natural rubber development program called for an 8,000 hectare expansion in rubber cultivation over the 1970-80 period. Production targets were to be achieved via a combination of industrial and villager owned plantation system. Table A-11 indicates that 34,869 hectares were under natural rubber cultivation by 1980. Of these areas, 14,697 hectares were producing rubber. The overall area under natural rubber cultivation in 1980 represents a 16,869 hectares (94 percent) increase over the targeted level of 18,000 hectares for 1980 [38].

The 1976-80 Diversification Program

Overview

The 1976-80 Development Plan [39] argued forcefully that there was a need for a sustained increase in the revenue to producers of agricultural commodities. The rationales given were (1) increased income was necessary to improve farmers' standard of living and (2) additional income would enable farmers to save an increasing relative share of their income for investments in domestic enterprises. In

¹²IRCA is acronym for Institut de Recherches de Caoutchouc (Research Institute for Rubber).

short, the 1976-80 Plan saw expanded producer revenues as a vital ingredient in domestic capital formation and internally induced economic growth and development. The Plan identified income distribution as a specific problematic area for national attention. It specified, as a high priority area, increased levels of income for certain perceived disadvantaged regions. These regions were (1) Savannah regions, (2) subregions along the Bandama rivers, and (3) the western region.

Other general strategies that were pursued were:

- An increase in employment potentials in the agricultural sector.
- Modernization of agricultural activities, and the improvement of the family farm structures to facilitate change from traditional or semi-traditional to modern agricultural activities.
- Ivorianization of wage and non-wage earning agricultural jobs.
- Inducing stability in agricultural export earnings through diversification of export commodities.
- Initiate a set of sectoral programs that would strengthen the earlier efforts of the 1971-75 Diversification Program, but oriented towards solution of specific problems in certain subsectors of the agricultural economy.

The Plan spelled out specific programmatic objectives for selected agricultural commodities produced in the forested zone. For coffee and cocoa, the stated objectives were (1) improved quality of coffee produced, (2) increased levels of production for both coffee and cocoa, (3) increased level of productivity of factors of production used in

coffee and cocoa production, and (4) progressively shifting coffee and cocoa supplies from traditional varieties to improved high yielding varieties. For oil palm, coconut palm and rubber, the stated objectives were (1) increased production of oil palm and oil palm products and coconut (copra), (2) increase the relative share of villagers' plantations coconut production in the national coconut production, (3) shift and concentrate industrial block oil palm plantation activities to the southwestern region, and (4) expand the hectarage of natural rubber under plantation type of production. For banana and pineapple, the Plan [39] specified the expansion of modern banana plantations under Ivorian ownership, and the process of structural changes in pineapple subsector to increase the number of Ivorian pineapple producers.

Table 13 shows the projected hectarage under selected export crops grown primarily in the forested zone over the 1975-1985 period. The projections were based on the notion that coffee, cocoa, oil palm, coconut and rubber would increase via improved genetic stock. The projected growth rates in values of forested zone export agricultural products for the period 1975-1985 was 6.6 percent per annum, compared to 15.8 percent and 7.3 percent for the Savannah zone and the country as a whole. In all cases, the projected annual rates of growth in the values of export crops were consistently higher than the projected growth rates for food crops (Table 14). Although revenues from oil palms and coconut palms were expected to increase steadily at an average annual rate of 11 percent over the 1975-1980 and 1980-1985 period, it would appear that coffee and cocoa revenues were expected to represent 24 percent and 37 percent, respectively, of total revenues generated by industrial crops in 1985 (Table 15). Combined coffee and cocoa revenues were projected

Table 13. Projected areas under the main perennial crops in the forested zone, Ivory Coast, selected years, 1975-1985

Crops/Type of Production	1975	1980	1985
	-----hectares-----		
<u>Coffee</u>			
Traditional	1,167,000	1,127,000	974,000
Modern	36,500	102,700	192,700
Total coffee plantations	1,203,500	1,229,700	1,166,700
<u>Cocoa</u>			
Traditional	845,000	857,000	814,000
Modern	65,000	178,700	322,700
Total cocoa plantations	910,000	1,035,700	1,136,700
<u>Oil Palm</u>			
Industrial block plantations	44,023	60,523	65,523
Villagers plantations	27,651	43,151	60,151
Subtotal SODEPALM plantations	71,674	103,674	125,674
Private oil palm plantations	10,000	10,000	10,000
Total oil palm plantations	81,674	113,674	135,674
<u>Coconut Palm</u>			
Industrial block plantations	11,183	19,080	22,580
Villagers plantations	6,608	29,500	64,500
Subtotal SODEPALM	17,791	48,580	87,080
Private coconut plantations	20,000	25,000	25,000
Total coconut palm	37,791	73,580	112,080
Rubber tree plantations	16,580	40,070	64,720

Source: [39].

Table 14. Estimated values for agricultural production from peasant farms at 1975 price level, Ivory Coast, selected years, 1975-1985

	1975 value billion CFAF	Avg. annual rate of growth 1975-80 ---percent---	1980 value billion CFAF	Avg. annual rate of growth 1980-85 ---percent---	1985 value billion CFAF	Avg. annual rate of growth 1975-1985 ---percent---
Forested zone						
Industrial crops ^a	89.7	6.7	124.3	6.5	169.9	6.6
Food crops	60.1	5.5	78.5	2.3	87.9	3.9
Total	149.8	6.2	202.8	4.9	257.7	5.6
Savannah zone						
Industrial crops ^a	5.1	11.8	8.9	19.8	22.0	15.8
Food crops	38.5	8.3	57.4	7.7	83.4	8.0
Total	43.6	8.7	66.3	9.7	105.4	9.2
The country as a whole						
Industrial crops ^a	94.8	7.0	133.2	7.6	191.9	7.3
Food crops	98.6	6.6	135.9	4.7	171.2	5.7
Total	193.4	6.8	269.1	6.2	363.1	6.5

^aThese values do not include values from industrial block and European plantations.

Source: [39].

Table 15. Estimates of total agricultural production in values at 1975 price and annual rate of growth, Ivory Coast, selected years, 1975-1985

	1975	1980	1985	1975-1980	1980-1985
	---million CFA francs---			-----percent-----	
Food Crops					
Paddy rice	29,255	52,925	66,950	12.6	4.8
Other cereals	8,980	11,910	17,360	5.8	7.8
Feculents (starchy foods)	59,600	68,680	80,870	2.9	3.3
Other food crops	5,065	7,000	12,000	6.7	11.4
Subtotal	102,900	140,515	177,180	6.4	4.7
Industrial and Export Crops					
Coffee	40,500	49,500	54,000	4.1	1.7
Cocoa	40,250	58,625	84,000	7.8	7.4
Selected oil and coconut palms	6,580	11,130	19,090	11.1	11.4
Other crops from the forested region	12,720	19,145	33,680	8.5	12.0
Cotton	4,485	7,245	13,455	10.1	13.2
Sugar cane	290	3,750	13,750	66.8	29.7
Other crops from the savannah	600	1,650	8,500	22.4	38.8
Subtotal	105,425	151,045	226,475	7.4	8.4
Total	208,355	291,560	403,655	7.0	6.7

Source: [39].

to represent 34 percent of combined export crop and food crop revenues in 1985.

Other forested zone export crops (such as pineapple, banana and rubber) were projected to have average annual growth rates of 8.5 and 12.0 percent over the 1975-80 and 1980-85 periods, respectively (Table 15). The Plan noted that earlier government price guarantees had only served to increase the revenues to producers without a positive supply response among producers. Therefore, the Plan spelled out the need for increased productivity across the board in order to meet the ultimate development objectives. One such objective was increased income in selected regions of the country as a means of reducing the income differentials among regions.

The estimated per capita value of production in the agricultural sector of the forested region was CFAF 54,771 in 1975, compared to CFAF 28,874 in the Savannah region. The estimated national per capita value of production in the agricultural sector was CFAF 45,559 (Table 16). The per capita value of agricultural production of the forested region and country as a whole would be CFAF 63,686, and CFAF 73,428, respectively. In the forested zone, per capita gross revenues for export cash crops were expected to increase at an average annual rate of about 4.5 percent, compared to 3.2 percent for food crops over the 1975-1980 period. In the savannah region the per capita gross revenues for both export cash crops and food crops were expected to grow at much higher rates. Per capita agricultural gross revenue for the country was projected to grow at an average annual rate of 5.1 percent for the 1975-1980 period, and 4.7 percent over the 1980-1985 period [39]. Aggregate production revenues to farmers were projected to grow at a

Table 16. Trends in total farm and per capita value of production in the ecological zone, Ivory Coast for selected years, 1975-1985

	1975			1980			1985		
	Total production	Per capita production	---CFAF---	Total production	Per capita production	---CFAF---	Total production	Per capita production	---CFAF---
	-billion- CFAF			-billion- CFAF			-billion- CFAF		
Forested Zone									
Industrial Crops	89.7	32,797		124.3	40,821		169.9	51,641	
Food Crops	60.1	21,974		78.5	25,780		87.8	26,687	
Total	149.8	54,771		202.8	66,601		257.7	78,328	
Savannah Zone									
Industrial Crops	5.1	3,377		8.9	5,687		22.0	13,293	
Food Crops	38.5	25,497		57.4	36,677		82.4	50,393	
Total	43.6	28,874		66.3	42,364		105.4	63,686	
Country as a Whole									
Industrial Crops	94.8	22,332		133.2	28,894		191.9	38,807	
Food Crops	98.6	23,227		135.9	29,479		171.2	34,621	
Overall Total	193.4	45,559		269.1	58,373		363.1	73,428	

Source: [39].

rate of 6.2 percent per annum in the forested region, 8.7 percent in the savannah region, and 6.8 percent nationally over the 1975-1980 period. The bulk of the projected increase in aggregate and per capita agricultural revenues was assumed to come from increased productivity of the agricultural factors of production. These factor productivity gains would be the catalyst for projected structural changes in the farm sector [39].

The 1976 Development Plan projected a positive trend in output volume over the 1975-1985 period for commodities produced in the forested region. The value to producers for these crops was also projected to show a positive trend over the period (Table 17). Overall revenue generated by the industrial cash crops in the forested region was projected to increase from 100,050 million CFAF in 1975 to 138,400 million CFAF in 1980, which represents a 38.3 percent increase in gross nominal income from these crops. A similar rate of increase was projected over the 1980-85 period. Gross revenues generated by food crops in the forested region were expected to grow at an average 5.5 and 2.3 percent per annum over the 1975-80 and 1980-85 periods, respectively. The total gross farm revenue from both export and food crops was estimated to grow at an average annual rate of 5.7 percent over the 1975-85 period (Table 17).

Summary

In 1960, 78.3 percent of the Ivory Coast total agricultural export earnings was accounted for by coffee, cocoa and timber (Table 5). After spelling out the danger of having the national economy based on those three commodities, the Ministry of Planning pointed out the urgent need for industrial and export crops diversification [37]. Pioneering crops

Table 17. Estimated quantities and values to producers of the agricultural commodities produced in the forested region, Ivory Coast, selected years, 1975-1985

	1975	1980	1985	1975	1980	1985
	-----metric tons-----			---million CFA francs---		
Industrial crops						
Traditional oil palm	190,625	190,625	167,500	2,525	1,525	1,340
Selected oil palm	710,000	1,010,000	1,480,000	5,680	8,080	11,840
Coconut palm	18,000	61,000	145,000	900	3,050	7,250
Rubber	17,000	21,000	47,000	1,820	2,250	5,030
Coffee	270,000	330,000	360,000	40,500	49,500	54,000
Cocoa	230,000	335,000	480,000	40,250	58,625	84,000
Pineapple fruits for export	70,000	150,000	230,000	2,625	5,250	8,050
Banana for exports	160,000	200,000	220,000	3,200	4,000	4,600
Pineapple fruits for canning	155,000	215,000	270,000	1,200	1,720	2,160
Avocados	500	4,000	10,000	50	400	1,000
Miscellaneous	--	--	--	2,300	4,000	11,500
Subtotal	1,821,125	2,516,625	3,409,500	100,050	138,400	190,770
Food crops						
Paddy rice	290,000	450,000	485,000	18,850	30,825	31,525
Corn	115,000	135,000	155,000	2,990	3,510	4,030
Yam	900,000	980,000	1,020,000	18,000	20,800	24,500
Cassava	545,000	640,000	755,000	9,810	11,485	13,590
Plantain	780,000	900,000	1,060,000	7,800	9,000	10,600
Miscellaneous	210,000	230,000	265,000	2,200	2,300	2,650
Legumes	13,500	16,000	22,500	420	530	870
Subtotal	2,853,500	3,361,000	3,762,500	60,070	78,450	87,765
Overall total	4,674,625	5,877,625	7,172,000	160,120	216,850	278,535

Source: [39].

such as coffee and cocoa were to be grown using high yielding genetic stocks. Banana and pineapple were to be expanded, whereas modern ways of producing alternative crops such as oil palm, coconut palm and natural rubber were to be introduced through development of agro-industrial blocks at the villagers' level. Programs aimed at achieving the policy goal of diversification and income distribution were developed in the 1971-75 and 1976-80 five-year Development Plans [38,39]. The 1971-75 Plans emphasized growth of the agricultural sector, whereas the 1976-80 Plans strongly emphasized, among other things, the need for (a) an increase in the Ivorian ownership of the new type of farms, (b) a sustained growth in productivity in the agricultural sector, and (c) an improvement in the income distributional patterns in the rural sector.

CHAPTER IV CONCEPTUAL FRAMEWORK AND EMPIRICAL MODELS

Conceptual Framework

Approaches Towards Crop Diversification

Generally speaking, agricultural crop diversification has been viewed by economists as one solution for agricultural commodities facing adverse long-run market prospects. Also, crop diversification has been suggested as a means of accelerating economic growth and development in LDCs heavily dependent on their agricultural sector. Under these circumstances, crop diversification policies can be targeted at increasing the nation's export earnings by reducing the adverse effects of export price and quantity fluctuations and promoting improvement in the nation's income distribution pattern.

The concept of crop diversification can be defined in various ways. It can be defined as a movement away from monoculture, leading to the adoption of several crops in a given geographical area or farm unit. This implies that crop diversification can occur at either the national level, the regional, or at the farm level. Crop diversification can also be conceptualized as a transfer of land and other resources from one crop or crop combination to alternative crops or uses.

According to Finke and Swanson [10] crop diversification can be defined either within the context of "richness" or of "evenness." The concept of "richness" involves the idea of "how many" crops a given region or farm unit grows. The disadvantage of such a concept is that

it does not preclude the dominance of the crop mix by one or two crops. Thus, under this concept, crop diversification may not necessarily result in the reduction of monocultural practices, especially if there is persistent bias toward the dominant crops in the resource allocation process. On the other hand, emphasis may be placed on the relative importance of each crop in the crop mixture in the country, the region, or the farm unit. Interpreted as such, the concept of crop diversification is the one of "evenness," since it implies concern about the extent to which all crops in the area of interest are equally distributed. The drawback of this concept is that it neglects the differential impact of new technology on them. Competitive position and impact of new technology are all likely to affect crop diversification.

Addressing the problem of diversification in resource allocation and minimization in income variability, Heady [12, 13] defines two different aspects of diversification. The first aspect is related to planning under perfect knowledge. Under these circumstances the individual farmer wishing to maximize profit must equate the marginal rate of product substitution with the price ratio of the products. The second aspect of diversification is that of minimizing the variance of income. He points out that income variability can be reduced through diversification, only if the prices and yields of the products bear the proper correlations. Heady concluded that if returns for different enterprises do not have a high positive correlation then an increased number of farm enterprises will in turn increase the chance that a high income for one enterprise will accompany a low income for another.

In an agricultural diversification study in California, Carter et al. [6] point out that even though income can be stabilized through crop

diversification, the level of stabilized income may be lower than that generated by specialization. This situation leads farmers to choose between an unstable income at high average level, and a more stable income at a lower level. Using a linear programming approach to analyze the problem of alternative diversification opportunities on Costa Rican coffee farms, Bieber [5] found that (a) a change in technology in coffee production was both easier and cheaper than in other crops, to the extent that coffee production was more profitable than alternative crops, and (b) the cost of coffee trees removal would be higher for smaller farmers than for larger ones. It appears from Bieber's study that the effectiveness of diversification in reducing coffee production on most of the farms studied was dubious.

Crop diversification has the potential advantage of preventing inadequate resource allocation and overproduction that would otherwise prevail under monoculture, as a result of overreaction to "short run" advantageous price situations. Furthermore, crop diversification also offers some protection against high risks where (a) technological progress would provide comparative cost advantages to synthetic substitutes, (b) pest and disease problems increase uncertainty. According to Millikan and Hapgood [19] agricultural crop diversification may be advantageous if it fully utilizes labor, and reduces economic risks. Indeed, the allocation of labor resource requirements may be scheduled in such a way that one crop uses labor when another has a slack work period in the multi-cropping system.

Addressing some of the limitations faced by crop diversification programs, Dalrymple [7] points out that empirical evidence on the positive aspects of agricultural diversification is lacking, since

research has concentrated on a few major export crops. Moreover, there might be situations where the markets for alternative crops are not sufficient to absorb the expanding productions at profitable prices. As a larger number of crops are produced and the volume of some crops is reduced, a loss in economy of scale activities may result in reduced efficiency in some enterprises. Such a situation can be economically hazardous for new crops introduced without sufficient volume to utilize efficient processing equipment. Also, according to Krezdorn [15], the lack of experience or local scientific investigation to support a new enterprise may result in the innovation producers facing higher uncertainties with respect to the crop response to unfavorable factors and conditions.

Instability in the earnings of a specific crop has traditionally been attributed to the price and quantity variability components, as well as to the variability in the interaction component of these two variables [12, 13]. A United Nations study [49] of less developed countries agricultural export earning fluctuations emphasized the year-to-year price and quantity fluctuations, as well as cyclical swings in these two variables. Extrapolating these findings to the domestic level would suggest that fluctuations in agricultural earnings tend to be greater than those of price and quantity, when the two variables are considered individually. This would suggest that price and quantity are destabilizing each other. Furthermore, two-fifths of the fluctuations in export earnings were attributed to price, whereas quantity accounted for the remaining three-fifths. If these findings are applied to the Ivory Coast, the implications are that fluctuations attributed to quantity variation should be even larger, whereas that stemming from

price smaller, because of the characteristics of institutionalized domestic price stabilization policies.

A United Nations world economic survey indicated that prices and quantities have not always moved together [50]. The suggestion was that year-to-year short-term variations were explained by short-term supply shifts. These short-term shifts may have resulted from uncompensated crop failure in a given region, or from other exogenous factors, including, among other things, drought, or endogeneous cobweb situations, depending on the extent to which producers are sensitive to price changes.

Approaches Towards Income Distribution

Generally speaking, it has been observed that the poor are disproportionately located in rural areas, engaged in agriculture and related occupations, whereas the rich are urban dwellers. According to Ahluwalia and Chenery [2], a typical LDC is characterized by 80 percent of the rural population receiving 50 percent of the rural income, with the rest of the rural income going to the upper 20 percent of the rural population. Nevertheless, income is found to be less inequally distributed within the agricultural sector than the non-agricultural sector. A similar observation has been made by Kuznets [16] who indicates that although the average per capita income of the rural population is usually lower than that of the urban population, the inequality in percentage shares within the distribution for rural population is narrower than that of the urban population, even when based on annual income.

In his analysis of how social-economic organization in the United States perpetuates interregional growth and incomes differentials,

Hughes [14] argued that by its very nature, a free market system of organization causes advanced regions to grow, in part, at the expense of other regions. As a result of such patterns, once regional income differences emerge they tend to become self-perpetuating, unless some exogenous influence, such as government, acts to offset market forces. Describing the patterns of regional inequality and the process of national development in several countries, Williamson [51] concluded that rising regional income disparities and increasing regional dualism were typical of early development stages. On the other hand, regional convergence and disappearance of severe regional inequality problems were associated with more mature stages of national growth and development. He further suggested that regional inequality in the countries studied was much more extensive within the agricultural than within the industrial sector, and that labor participation rates, in part, contribute to regional income per capita differentials. According to Williamson, the high degree of regional income disparities in countries such as Spain, Brazil, Italy, Yugoslavia, and the United States (at the turn of the century) were due to tremendous differentials in agricultural productivity, and significant regional differences in economic structure. He also suggested that the role and significance of the industrial sector dualism in the overall regional income disparities appeared to have been grossly exaggerated according to more recent development literature.

Neoclassical equilibrium theory of income distribution is based on functional income rather than personal incomes. This means that given the input-output relationships and factor supply conditions, competitive market equilibrium solutions will result in rewarding each factor by the

value of its marginal product. Under these circumstances, the neoclassical theory has serious limitations in explaining how income is distributed under situations such as market imperfections or economies of scale. In the Ivory Coast, the likelihood of market imperfection exists. In fact, because of various governmental incentive programs, prices of several factors of production are not likely to reflect their opportunity cost.

A number of income inequality indicators have been developed by economists [48,53]. The Gini concentration ratio is one such indicator. It can be defined as one-half of a weighted average of all absolute differences between the deflated per capita income. The weights in the Gini concentration ratio are the products of the corresponding population income shares. The minimum value of the index is zero, which is obtained when the per capita income shares are all equal. The maximum value of 1.0 is attained when there is perfect inequality suggesting that one group of persons earn all the income. If the primary area of concern is with the absolute degree of inequality, then the Gini coefficient is more appropriate for this purpose. Furthermore, the use of the Gini coefficient does not require the assumption of income being normally distributed. However, a major limitation of the Gini coefficient is that it does not lend itself to the between-group and within-group decompositions of the inequality index. This results from the fact that absolute differences are used in computing the ratio, and such a procedure is inappropriate for the between-group and within-group decompositions of the index.

Another commonly used indicator is the variance of the logarithms of the income shares. This indicator is useful when income is

approximately lognormally distributed, and whenever one is interested in the relative inequality in the low ranges. The advantage of this measure of inequality over the Gini concentration ratio rests on the fact that the former can be decomposed into the between-set and within-set logarithmic income variances. The disadvantage of this measure of inequality is associated with the fact that the variance of the income logarithms is the second-moment extension of the geometric mean of the individual incomes, instead of the arithmetic mean, which is the per capita income. The arithmetic mean is more appropriate because it is directly related to national or regional income.

Measuring income distribution can also be viewed as a measurement of dispersion with respect to regional or national per capita income. This view would favor the standard deviation as an indicator of inequality. However, in order to take into account differences in mean incomes in the different distributions, the standard deviation is divided by the mean in order to obtain the coefficient of variation. The coefficient of variation measure of inequality is a simple procedure. However, its use is based on the assumption that income is normally distributed in order for the standard deviation to be an unbiased estimate of the skewness.

Another income inequality indicator which is considered superior in many respects to the previously mentioned measures, is the information index measure [48]. Like the Gini concentration ratio, its use does not require any assumption with respect to normality of the distribution of income. However, the information index measure is superior to the Gini measure because the former can be expressed as the sum of its between-group and within-group inequality measures, while the latter

does not lend itself to such purposes. The maximum value of the information index of inequality is the logarithm of the total number of units. This value increases when the number of units increases. On the other hand, the lower limit of the index is zero which implies perfect equality. The rationale behind the increase in the upper limit as the number of units increases can be illustrated by an example. Assume there are two communities, one with two individuals, and the other with 100 individuals. If one individual in each of the two communities receives the value of all goods and services and the others nothing, it will only be natural to say that when inequality is at its peak in both communities, the community with 100 individuals is more unequal than the one with two individuals. This is the case because of the fact that logarithm of 100 is greater than logarithm of 2. The information measure of inequality is preferable to the variance of logarithms of incomes measure of inequality. This is because it deals with per capita income, in addition to the fact that no assumption on lognormal distribution is required to make use of it. However, use of the information measure is said to be more appropriate when one is primarily interested in the relative inequality in the medium or high ranges of the distributional schedule [53].

In conclusion, it can be said that of a number of traditional income inequality measures, some are better indicators than others, depending on the specific area of concern. However, the general consensus among economists is that no single measure can capture all the important factors in a given distribution.

Empirical Models

The empirical models used to meet the four specific objectives of the study (pp. 33-34) are given below.

Objective 1

A crop diversification index based on information theory [48] was used to meet part (a) of Objective 1. This diversification index can then be written as:

$$CD_t = \left[\sum_{i=1}^N l_i \log \left(\frac{1}{l_i} \right) \right]_t \quad (1)$$

Rearranging equation (1) results in

$$CD_t = \left[- \sum_{i=1}^N l_i \log (l_i) \right]_t \quad (2)$$

where,

CD_t = crop diversification index in period t, with value varying between zero and the value of $\log N$,

l_i = proportion of land resource allocated to the i th crop,

$\log$ = natural log,

N = total number of crops involved in the study.

According to the specification of equation (2) complete diversification exists when each crop is allocated the same amount of land. On the other hand, complete specialization exists when a single crop is allocated the total amount of land resource. In the case of complete diversification, the value of equation (2) will correspond with its maximum, which is $\log N$. In the case of complete specialization the value of equation (2) will correspond with its minimum value $\log 1$, which is zero.

The second component of Objective 1 (Objective 1(b)) which deals with identification of the crop diversification or specialization patterns within and between regions will be accomplished through the exponential trend procedure given below.

$$CD_t = Ae^{RT} \quad (3)$$

where,

CD_t = crop diversification index in period t, as defined in equation (2),

A = scale of crop diversification,

R = rate of growth of crop diversification,

T = time trend.

Results obtained from equation (2) for the period covered by the study will enable us to compute the parameters A and R from the above exponential trend procedure.

Objective 2

In order to determine and evaluate the impact of export and industrial cash crop diversification on farmer agricultural earnings, a regression model will be used for the forested zone and each of its three subregions as indicated by equation (4).

$$AE_{jt} = f(CD_{jt}, CD_{jt}^2, T, U_{jt}) \quad (4)$$

with $j=1...4$ for the forested zone as a whole and the three subregions.

where,

AE_{jt} = agricultural earnings in the j^{th} region or subregion for period t ,

CD_{jt} = index of crop diversification in the j^{th} region or subregion for period t ,

T = time, a proxy variable for other factors affecting agricultural earnings over the observational period,

U_{jt} = disturbance term in the j^{th} region or subregion for period t .

Equation (4) is expected to reveal the nature of the relationship between the agricultural earnings and the level of crop diversification in the forested zone and each subregion. Furthermore, equation (4) will identify through its quadratic structure the trend in the agricultural earnings beyond the level of diversification at which these earnings reach their minimum levels in the regions and subregions.

Objective 3

In order to meet this objective it is necessary to (a) develop some operational indices of export and industrial crop earnings instability to farmers in the forested zone, and (b) assess the impact of crop diversification (or specialization) on these earnings stability indices. If this objective can be met, it would provide important insights into the economic relationships between the stability of earnings (a major determinant of income growth and risk propensity) and potential growth and development characteristics of alternative intensity levels of crop diversification programs in the forested zone.

Masse11 [17] developed two trend-corrected measures for earnings instability. The first measure can be written:

$$IN_1 = \sqrt{\frac{\sum (U_t)^2}{n}} \quad (5)$$

where,

IN_1 = instability index in earnings,

U_t = disturbance term from fitting a linear regression to earnings, expressed as a function of time,

n = number of years in the series,

$\bar{Z}$ = average earnings over the n year period.

A second measure can be written:

$$IN_2 = \frac{\sum W_t}{n} \quad (6)$$

with,

$$W_t = \frac{|U_{t+1} - U_t|}{\text{Max } [Z_t, Z_{t+1}]} \quad (7)$$

where,

IN_2 = average annual instability index in earnings,

W_t = annual instability index in year t ,

n and U_t = as defined in equation (5),

U_{t+1} = disturbance term in period $t+1$ associated with Z_{t+1} ,

Z_t = earnings in period t , and

Z_{t+1} = earnings in period $t+1$.

In a later study, Massel [18] used an exponential regression form to derive the disturbance terms used in equations (5) and (7). In this study, analysis will be focused on year-to-year earnings variability, instead of the level of instability, or the average annual percentage change rate of earnings over the period covered. In this respect,

equation (7) becomes more economically appealing as a measure of year-to-year earnings variability. It should be pointed out, however, that equation (7) assumes that the points from which earnings deviations occur are nonstationary points. In this study, it is assumed that deviations are occurring around the average earnings trend value. Hence, the adjusted instability indices for the export and industrial cash crop earnings will be written as:

$$IN_{jt} = \frac{|E_{j,t+1} - E_{jt}|}{Z_j} \quad (8)$$

with $j=1, \dots, 4$ for the forested zone as a whole and the three subregions

where,

IN_{jt} = adjusted Massell annual instability index in earnings from export and industrial cash crops in the j^{th} region or subregion in period t ,

$E_{jt}, E_{j,t+1}$ = disturbance terms associated with earnings Z_{jt} and $Z_{j,t+1}$ from export and industrial cash crops,

Z_j = export and industrial crops' average earnings trend from which deviations take place in the j^{th} region or subregion.

The use of exponential trend to fit the export and industrial cash crops earnings data, as a means of generating the disturbance terms (E_{jt} s), is based on the theoretical justification that countries tend to plan in term of the growth rate rather than in terms of absolute increments [18].

Results from equation (8) will be used in equations (9), (10) and (11) as follows:

$$IN_{jt} = f(CD_{jt}, \alpha_{jt}) \quad (9)$$

$$IN_{jt} = f(ED_{jt}, \gamma_{jt}) \quad (10)$$

$$IN_{jt} = f(ED_{jt}, ED_{jt}^2, \beta_{jt}) \quad (11)$$

where,

IN_{jt} = as defined in equation (8),

CD_{jt} = as defined in equation (4),

ED_{jt} = earning diversification index of the j^{th} region or subregion for period t , developed as in equations (1) and (2), and

α_{jt} , γ_{jt} and β_{jt} = disturbance terms for the j^{th} region or subregion in period t .

The coefficient of CD_{jt} in equation (9) will depict the nature of the relationship between the instability in earnings from the industrial and export crops and crop diversification in the j^{th} region or subregion. The coefficient of ED_{jt} in equation (10) will provide some insights on the relationship between the instability in earnings and the earning diversity index of the j^{th} region, as a result of the prevailing level of crop diversification in the forested zone and its subregions. Furthermore, the coefficient of the quadratic term ED_{jt}^2 in equation (11) will show the trend in earning instability beyond the level of earning diversity index at which earning instability reaches its minimum.

Objective 4

The information theory income index as defined by Theil [48] will be used to meet Objective 4. This income inequality index has been found to be quite useful in assessing the degree of income inequality based on grouped and ungrouped data. In addition, this index has the desirable properties of (a) being free of the normality of income

distribution assumption inherent in the Gini coefficient, and (b) unlike the Gini coefficient, this index has aggregation properties. These properties enable expression of the overall income inequality as a sum of its components. The index as used in this study can be written:

$$I_{jk} = \sum_{j=1} Y_j \log \frac{Y_j}{X_j} + \sum_{j=1} Y_j \left[\frac{y_k}{Y_j} \log \frac{\frac{y_k}{Y_j}}{\frac{x_k}{X_j}} \right] \quad (12)$$

where,

I_{jk} = the income inequality index in the rural areas of the forested region,

Y_j = the agricultural money and subsistence income share of the j^{th} subregion of the forested region,

X_j = the rural population share of the j^{th} subregion of the forested region,

y_k = the forested zone agricultural money and subsistence income share of the k^{th} department in the j^{th} subregion, and

x_k = the forested zone rural population share of the k^{th} department in the j^{th} subregion.

The first term on the right-hand side of equation (12) depicts the between-region inequalities, whereas the second term depicts the within-region inequalities. When per capita agricultural money and

subsistence income in all the subregions is the same, $\frac{Y_j}{X_j}$ is unity.

Hence, $\log \frac{Y_j}{X_j}$ is zero. Under these circumstances the between region inequality term in equation (12) is eliminated. In any other case, the between region inequality term will be positive, simply because its value depends on the extend to which per capita incomes differ. On the other hand, when all agricultural money and subsistence income is

received by one subregion, the income inequality index of the forested region will assume a value of $\log 3$, which is the logarithm of the total number of subregions.

Data Base, Assumptions and Adjustment Procedures

Data Base

Data used to meet the study objectives are primarily from secondary sources such as SODEPALM, SAPH,¹³ COFRUITEL,¹⁴ the ministries of Agriculture, Finance and Planning of the Ivory Coast, the World Bank, and the United Nations. In addition, independent studies and surveys by the Ministry of Planning pertaining to the forested region were also used.

Assumptions and Adjustment Procedures

Estimates of hectareage planted under the various cropping programs were obtained from the ministries of Agriculture or Planning or from statutory agencies. In those cases where the 1980 planted area was not available, it was assumed to have remained at its 1979 level. Planted areas of crops such as banana and pineapple were estimated based on yields obtained from COFRUITEL. Before computing the calendar year earnings from coffee and cocoa for the region and subregions, the marketed quantities of each crop were transformed from the harvest season basis (which runs over two calendar years) to calendar year quantities using an adjustment procedure suggested by the Ministry of Planning [39]. The procedure states that production of calendar year N

¹³SAPH is an acronym for African Company for Planting Natural Rubber.

¹⁴COFRUITEL is an acronym for Cooperative for Fruits and Vegetables.

is composed of 90 percent of the N-1 and N harvest season, and 10 percent of the N and N+1 harvest season. Data on coffee and cocoa productions and marketed quantities in the forested zone and subregions were not available for the 1960-63 period. Because these missing data were not randomly distributed, traditional missing data econometric procedures were not used to adjust the data set. Consequently, the estimating procedures used in meeting the earnings components of study objectives are based on data for the 1964-80 period. Prior to graphically mapping the production of the various crops, oil palm bunch production was substituted for by its equivalent in palm oil and kernel, which represents an average 25 percent of palm bunch production. Price index for the rural area, as developed by the Ministry of Planning, was 182.4 in 1975, with 1965 as base year [27]. The 1980 rural area price index was assumed to have increased at its 1965-75 annual rate of 6.19 percent. The 1980 forested zone and subregion rural population levels were estimated assuming that the regional and subregional rural populations grew at their respective 1965-75 annual rates of growth over the 1965-80 period.

Summary

Economists have viewed diversification in the agricultural sector as a solution for agricultural activities facing unfavorable long-run market prospects. This view is based on the argument that diversification can reduce the adverse effects of price and quantity fluctuations on farm and national incomes. Conceptually, diversification can be viewed as a movement away from monoculture or as a transfer of resources, such as land, capital and labor, from one crop or crop combination to alternative crops or combinations. Crop

diversification can also be viewed within the context of "richness" or of "evenness." While the former involves the idea of "how many" crops are grown, the latter is concerned with the extent to which land, capital and labor are allocated among the targeted crops in the area of interest. The "evenness" concept is used in this study, because it has dynamic economic implications in addition to the fact that the study deals with a given number of crops. Income variability can be reduced through diversification only if the prices and yields of the products bear the proper correlations. On the other hand, stabilized income resulting from diversification may be lower than that generated by specialization. Furthermore, diversification might be effectively constrained by macroeconomic factors such as a low research base and limited marketing opportunities for alternative crops.

In the area of distribution, it has been observed that the poor people, disproportionately located in rural areas, are engaged in agriculture and related activities, whereas most of the rich people reside in urban areas. Nevertheless, income has been found to be less inequally distributed within the agricultural sector than the nonagricultural sector. There is a contention that a free market system organization will cause the more advanced regions to grow at the expense of other regions. It has also been argued that increasing regional dualism is typical of early development stages, whereas the disappearance of severe regional inequality problems are associated with more mature stages of national growth and development. The neoclassical equilibrium theory of income distribution has limitations in explaining deep seated income distribution problems because it is based on functional income rather than personal income. Even though there is a

connection between the functional and personal incomes, given the fact that the incomes to the factors of production (land, capital and labor) are merely incomes to their owners, the neoclassical theory of income distribution has become inappropriate in situations of market imperfections or economies of scale. The information theory inequality index was used in the present study.

The four specific objectives of the study are being met through the use of diversification, instability and income inequality indices within an operational regression analysis approach. The data base for the study is from secondary sources.

CHAPTER V
EMPIRICAL FINDINGS

Interregional and Intra-regional Diversification Levels
and Pattern

Results from the estimating procedures given in equations (1) and (2) indicate that when the concept of diversification is statistically operationalized as "evenness" in crop mixture, the forested zone and its three subregions experienced relative increases in their degrees of diversification over the 1960-80 period (Table 18). The estimated indices for the various regional entities indicate that the level of diversification in the Eastern Forested Region was persistently the highest over the 1960-80 period. In the Eastern Forested Region, the diversification index moved from a value of 81.9 percent in 1960 and attained its highest value of 112.3 percent in 1980. The second highest degree of diversification was achieved in the forested region as a whole in 1980, with an index value of about 104.0 percent. The maximum value of the index is the logarithm of the total number of crops (units). As such, the estimated maximum value of the diversification level would be 1.946 or 194.6 percent. Based on this consideration, Table 18 suggests that the Central Forested Region exhibited a persistently slower pace of diversification, relative to the other two subregions and the forested zone in general, over the 1960-80 period. The index only moved from a value of 63 percent in 1960 to 76.6 percent in 1980. On the other hand, the Western Forested Region, with a diversification index of about 100.0 percent in 1980 compared to 25.3 percent in 1960, is the subregion which

Table 18. Crop diversification indices^a in the forested zone and its subregions, Ivory Coast, 1960-1980.

Years	Forested Region	Eastern Forested Region	Central Forested Region	Western Forested Region
-----percent-----				
1960	81.9381	82.3415	63.0069	25.3148
1961	82.6904	83.3408	63.6628	26.0490
1962	83.9731	85.0696	64.2720	26.9550
1963	85.4059	86.9910	64.8622	27.7314
1964	86.0350	87.8375	65.4553	28.5896
1965	86.9058	89.0155	65.9846	29.4396
1966	89.2580	91.8725	68.3770	30.4193
1967	92.7427	95.7550	71.0427	38.0138
1968	95.5708	99.1746	72.8466	45.4031
1969	97.9175	101.8924	74.2565	51.1302
1970	100.3667	105.2382	75.7462	54.4232
1971	100.7937	106.4510	76.0559	55.0296
1972	101.1195	107.5053	76.6030	55.9844
1973	95.4085	104.0735	74.4693	65.6353
1974	97.5826	108.5657	75.5652	64.4842
1975	97.9777	108.4304	75.5507	67.8093
1976	98.4723	108.5941	76.2891	74.8727
1977	99.9373	109.0699	76.3924	85.2343
1978	100.9359	109.1449	76.5320	89.8509
1979	103.3920	111.7862	76.2837	98.2473
1980	103.9629	112.3042	76.6514	99.8018

^aAs estimated by equations (1) and (2).

experienced the most active pace in its diversification patterns. Since a slow pace of diversification implies a higher degree of specialization (crop concentration) and the converse, it was thought that a crop concentration index would provide supporting evidence of the diversification (specialization) levels as indicated by the results of equations (1) and (2) (Table 18). The Herfindahl index is one such measure of concentration. This index was computed as explained in Appendix C.¹⁵ The Herfindahl index supports the finding that the highest level of crop concentration (low diversification) over the 1960-80 period existed in the Central Forested Region, whereas the lowest degree of specialization (high diversification) was experienced in the Eastern Forested Region (Table 19).

The maximum attainable value of the Herfindahl concentration index is 1.0 or 100.0 percent, which translates into specialization in one activity. Its minimum value is zero, which corresponds to the maximum level of diversification. Data in Table 19 indicate that the Western Forested Region underwent a continuous and high rate of decline in crop concentration from 1960 to 1980. These findings strongly substantiate those obtained from the information theory procedures as presented in equation (1) and (2). Indeed, results in Table 19 show that in 1980, the Central Forested Region was the most specialized subregion, followed by the Western Forested Region, the forested zone as a whole, and the Eastern Forested Region.

¹⁵The Herfindahl index is an appropriate corroborative index for results derived from the information index relative to this particular study objective. However, certain restrictive statistical and economic properties of the Herfindahl index precluded its use for meeting other objectives.

Table 19. Crop concentration indices^a in the forested zone and its subregions, Ivory Coast, 1960-1980.

Years	Forested Region	Eastern Forested Region	Central Forested Region	Western Forested Region
-----percent-----				
1960	48.5492	47.4644	56.2489	88.3063
1961	48.4603	47.2337	55.6302	87.8072
1962	48.2585	46.8469	55.0459	87.2035
1963	47.9936	46.3798	54.4891	86.6665
1964	47.9136	46.1851	53.9419	86.0785
1965	47.7688	45.9040	53.4352	85.4900
1966	47.2073	45.1311	52.6274	84.7752
1967	46.2383	44.0580	51.6855	81.4304
1968	45.3932	43.1376	50.9310	77.5630
1969	44.6471	42.3778	50.2826	74.4938
1970	43.8515	41.4003	49.6955	72.4681
1971	43.7730	41.1280	49.4309	72.0156
1972	43.8046	41.0584	49.1347	71.3372
1973	44.5908	41.6658	49.1817	62.8629
1974	44.3421	40.4961	48.9769	64.5976
1975	44.1959	40.4807	48.9701	63.1421
1976	44.0245	40.4177	48.7995	60.5186
1977	43.5280	40.2492	48.7655	55.8323
1978	43.2910	40.3551	48.7336	53.9714
1979	41.8279	39.1773	49.2908	47.2060
1980	41.6864	39.0521	49.2154	46.6408

^aComputed from the Herfindahl concentration index procedure as specified in Appendix C.

In terms of diversification pattern, Figure 7 clearly indicates that the forested zone and its three subregions exhibited increasing trends in diversification over the 1960-80 period. On the other hand, Figure 8 shows that over the same period, the region and its subregions experienced sustained declining trends in crop concentration. Figures 7 and 8, taken together, reveal that although the highest degree of crop diversification (the lowest degree of crop concentration) was found in the Eastern Forested Region, the Western Forested Region, as the target region for various national diversification programs, exhibited the highest rate of growth in crop diversification (the highest rate of decline in crop concentration) over the 1960-80 period. Comparative subregional analysis indicates that the Central Forested Region was the most specialized of the three subregions over the last two years of the study period. This evidence in association with the slow pace of the crop diversification process in the Central Forested Region suggests that the situation in this subregion depicts an "illusionally" high pattern of crop diversification based on the number of crops grown (Table A-13). In reality, in terms of land resource allocation among crops, it appears that only a moderate level of crop diversification has been achieved in this subregion. As mentioned earlier, the level of diversification achieved in the forested zone in general, was only second to that experienced in the Eastern Forested Region over the 1960-80 period. However, if the rate of growth in crop diversification in the Western Forested Region is maintained at its current level, this subregion could achieve the highest degree of diversification in the forested zone by the year 1985.

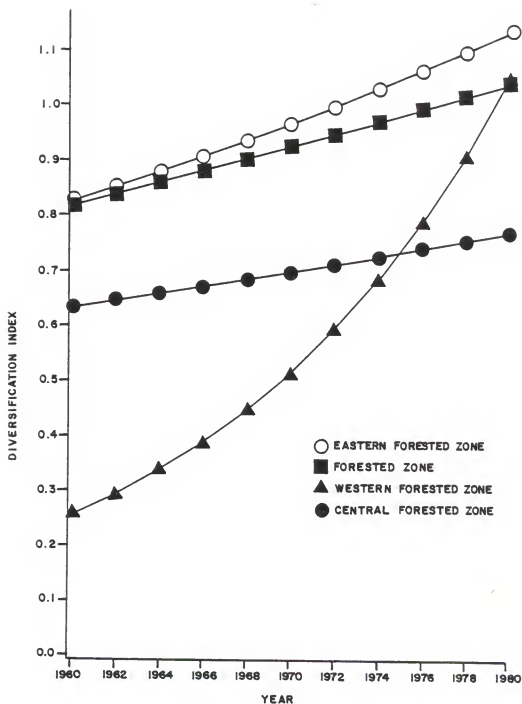


Figure 7. Industrial and export crop diversification trends in the Forested Region and its subregions as estimated with equation (3).

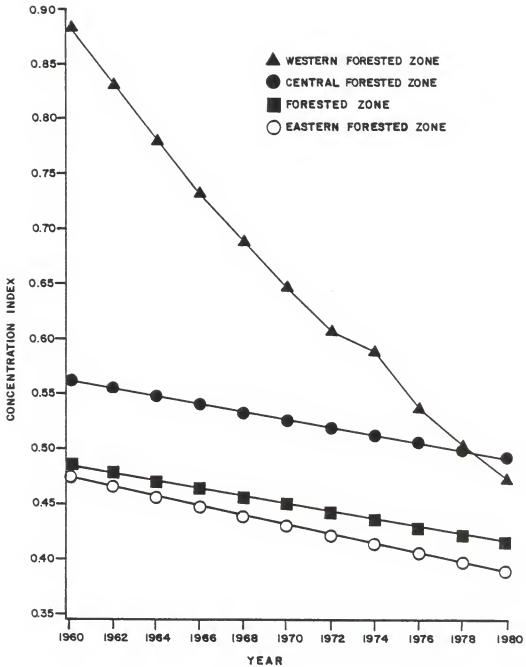


Figure 8. Industrial and export crop concentration trends in the Forested Region and its subregions, as estimated with the Herfindahl index (equation C-8).

Data in Table 18 were partitioned into three subperiod data sets in order to identify rates of change in the intra-series diversification indices of the forested zone and its subregions over the 1960-80 period. Results of such an intra-series data analysis suggest that the region as a whole and the subregions experienced a decline in annual rates of diversification over the 1975-80 subperiod compared to the 1965-75 subperiod. However, the largest annual rate of decline in diversification between the two subperiods occurred in the Eastern Forested Region (1.30 percent), followed by the Central Forested Region (1.10 percent). The Forested Region as a whole registered a modest annual rate of decline in its diversification pattern (0.01 percent) over the 1975-80 subperiod, whereas the Western Forested Region experienced a 0.66 percent decline in its rate (Table 20). Table 20 further indicates that, over the 1960-80 period, crop diversification in the forested zone grew at an annual rate of 1.20 percent. An identical rate of growth was experienced over the 1960-65, 1965-75 and 1975-80 subperiods. By comparison, the Eastern Forested Region experienced an increase in its rate of diversification from 1.60 percent in the first subperiod to 2.0 percent in the second, then a decline to 0.70 percent over the third subperiod. The rate of diversification in the Central Forested Region exhibited a pattern similar to that of the Eastern Forested Region, but at a comparatively lower level of diversification. The Western Forested Region experienced a 3.10 percent annual rate of increase in the diversification index over the 1960-65 subperiod. This rate increased to 8.70 percent over the second subperiod before experiencing a decline to 8.04 percent over the 1975-80 subperiod. The relatively high rates of growth in diversification exhibited over the

Table 20. Rate of change in diversification indices for the forested zone and its subregions, Ivory Coast, 1960-1980

Regions and Subregions	Annual rate of change in diversification				Difference between (3) and (2) (5)	Difference between (4) and (3) (6)
	1960-1980 (1)	1960-1965 (2)	1965-1975 (3)	1975-1980 (4)		
	-----percent-----					
Forested Region	1.20	1.20	1.21	1.20	0.01	-0.01
Eastern Forested Region	1.60	1.60	2.00	0.70	0.40	-1.30
Central Forested Region	1.00	0.92	1.40	0.30	0.48	-1.10
Western Forested Region	7.10	3.10	8.70	8.04	5.60	-0.66

^aA positive sign in columns (5) and (6) means that the region or subregion increased its rate of growth in diversification, whereas a negative sign indicates that the region or subregion slowed its rate of growth in diversification.

1960-80 period in the Western Forested Region, as well as over the subperiods, in all probability was related to the ear-marking of this region as the target zone for an intensified national diversification program. Although the results indicate persistent differentials in the degree and speed of diversification in the forested zone and its three subregions and the fact that these regions all experienced declines in their rates of diversification over the 1975-80 subperiod, the evidence strongly suggests that there was some element of success to government diversification programs in the region. It is obvious, however, that continued and higher levels of success will be directly related to not only continuation of a vigorous program but also implementation of programs to eliminate potential subregional economic bottlenecks. These subregional bottlenecks could arise from (a) pursuit of an extensive system of production at the expense of yield improvement practices, (b) difficulties associated with aging tree crop plantations, (c) decisions related to the waiting time period between establishing a plantation of one of the alternative crops and its year of bearings, and (d) the dilemma resulting from a persistent subregional labor shortage. These problems should be carefully addressed if acceleration of the positive trends of diversification in the forested zone and its subregions continues to be an objective.

Impact of Crop Diversification on Producer Earnings

The estimating procedure used in equation (4) to meet Objective 2 of the study provides the following results.

Forested Zone:

$$\begin{aligned} AEF_t &= 5237437.88^{****} - 109400.45CD_t^{****} \\ &\quad (1007547.62) \quad (21406.98) \\ &+ 567.09CD_t^2^{****} + 10672.59T^{****} \\ &\quad (113.69) \quad (1143.25) \\ \bar{R}^2 &= .94; \quad D.W. = .74; \end{aligned}$$

Eastern Forested Region:

$$\begin{aligned} AEE_t &= 1222110.97^{***} - 23742.73CD_t^{**} \\ &\quad (359461.79) \quad (7538.47) \\ &+ 113.65CD_t^2^{*} + 5483.26T^{****} \\ &\quad (39.78) \quad (1017.13) \\ \bar{R}^2 &= .95; \quad D.W. = .98; \end{aligned}$$

Central Forested Region:

$$\begin{aligned} AEC_t &= 416022.41 - 9114.80CD_t \\ &\quad (950269.58) \quad (27011.67) \\ &+ 42.12CD_t^2 + 5670.24T^{****} \\ &\quad (191.77) \quad (686.23) \\ \bar{R}^2 &= .90; \quad D.W. = .54; \end{aligned}$$

Western Forested Region:

$$\begin{aligned} AEW_t &= 9380.93^{**} - 365.83CD_t^{**} \\ &\quad (2786.56) \quad (116.65) \\ &+ 4.30CD_t^2^{****} + 186.90T \\ &\quad (.51) \quad (321.45) \\ \bar{R}^2 &= .97; \quad D.W. = 2.90; \end{aligned}$$

where,

AEF_t = value of the industrial and export crop earnings in the
Forested Zone as a whole,

AEE_t = value of the industrial and export crop earnings in the Eastern Forested Region,

AEC_t = value of the industrial and export crop earnings in the Central Forested Region,

AEW_t = value of the industrial and export crop earnings in the Western Forested Region,

CD_t = index of crop diversification as defined in equations (1) and (2),

T = time as previously defined in equation (4),

**** = b-coefficient significant at the .1 percent level,

*** = b-coefficient significant at the .5 percent level,

** = b-coefficient significant at the 1 percent level,

* = b-coefficient significant at the 5 percent level,

() = values in parentheses are standard error,

$\bar{R}^2$ = adjusted coefficient of determination which takes into account the degrees of freedom (number of residuals free to vary) in measuring the explanatory power of the independent variables in the regression model.

Except for the central and western subregions, the regression coefficients for the forested zone and the eastern subregion were all significant at the 5 percent level. However, the signs of the coefficients for the forested zone as well as for the three subregions provide important insights into the nature of the relationship between crop diversification and the level of the industrial and export earnings. The coefficient of the linear term of the diversification variable (CD_t) carries a negative sign for each of the eastern, central

and western subregions as well as for the forested zone. For the forested zone and its eastern and western subregions, the magnitude of the coefficients and the standard errors suggest that these coefficients are significant at the 1 percent level. The quadratic term (CD_t^2) in the general region, the eastern and western subregions, carries positive coefficients that are all significant at the 5 percent level. The time variable was significant in all equations except for the western forested subregion. This evidence suggests that other influences measured by the time variable also affected agricultural earnings in the forested zone as well as in the eastern and central forested subregions. The Durbin-Watson statistics indicate that the test for first order autoregressive errors is inconclusive at the 1 percent level for the forested zone and its eastern subregion. Results for the western subregion show no autocorrelation in the disturbances. There is an indication of positive serial correlation in the central subregion of the forested zone. However, the OLS results indicate that most of the variation in earnings from this subregion is explained with time, while crop diversification shows little effect. Given the form of the function, the implication is that over a certain range of crop diversification the process adversely affected producer earnings from industrial and export crops. However, when the diversification process proceeds beyond a critical point there is a positive impact on the earnings from these crops. Computations based on results from equation (4) indicate that, in terms of diversification indices, these critical levels are 96, 104, 108, and 43 percent for the forested zone, the eastern, central and western subregions, respectively. Results in Table 18 suggest that the critical levels of diversification were achieved in

1968 for the western subregion, and in 1969 and 1970 for the forested zone and its eastern subregion, respectively. For the central subregion the value beyond which diversification would positively affect agricultural earnings was not reached over the study period.

Given the results from equation (4), the positive trends exhibited in the diversification indices, as computed in equation (3) (Figure 7) and the trends exhibited in producer earnings in Figure 9, there is some suggestion that CD levels observed in the latter years are associated with agricultural earnings that are equal to or greater than earnings at CD levels in the earlier years. The concomitant growth in the diversification indices (Table 18) and total agricultural earnings trends in the eastern and western forested subregions (Figure 9) also suggest that diversification has reached levels at which it has become more economically rewarding to proceed with the process rather than to specialize. However, it appears that the positive trend in agricultural earnings for the central forested subregion is associated with a relatively high degree of specialization. On the other hand, the diversification process in the Western Forested Region seems to have made the economic adjustments necessary to serve as a positive source of growth in producer earnings in certain regions of the Ivorian forested zone.

Impact of Crop Diversification on Agricultural Earnings Instability

The first aspect of Objective 3 was met by regressing the year-to-year regional earnings instability indices, as derived from equation (8) (Table B-1), against their respective diversification indices as derived in equation (1) (Table 18), and made operational in equation (9). The results of this procedure are shown as:

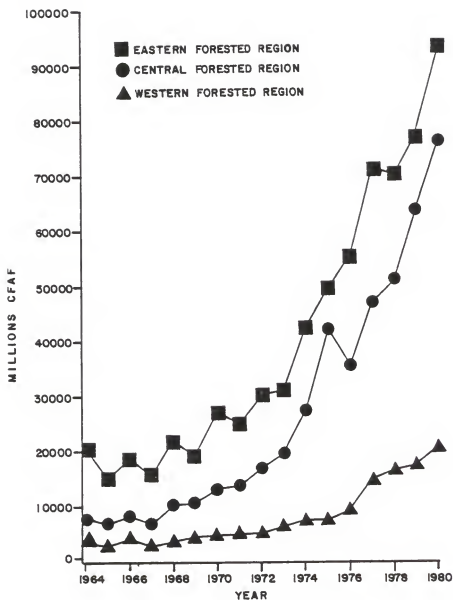


Figure 9. Trends in total earnings from the industrial and export crops in the three subregions of the forested zone

Forested Zone:

$$\begin{aligned} \text{INF}_t &= 10.381^{****} - .080\text{CD}_t^{***} \\ &\quad (2.41) \quad (.02) \\ \bar{R}^2 &=.37; \quad \text{D.W.}=1.54; \end{aligned}$$

Eastern Forested Region:

$$\begin{aligned} \text{INE}_t &= 6.253^{**} - .050\text{CD}_t^{**} \\ &\quad (2.22) \quad (.021) \\ \bar{R}^2 &=.21; \quad \text{D.W.}=1.65; \end{aligned}$$

Central Forested Region:

$$\begin{aligned} \text{INC}_t &= 10.974^{****} - .137\text{CD}_t^{****} \\ &\quad (2.44) \quad (.033) \\ \bar{R}^2 &=.49; \quad \text{D.W.}=1.49; \end{aligned}$$

Western Forested Region;

$$\begin{aligned} \text{INW}_t &= 1.572^* - .003\text{CD}_t \\ &\quad (.796) \quad (.012) \\ \bar{R}^2 &=-.062; \quad \text{D.W.}=1.61; \end{aligned}$$

where,

INF_t = industrial and export crop earnings instability index in the forested zone as a whole,

INE_t = industrial and export crop earnings instability index in the Eastern Forested Region,

INC_t = industrial and export crop earnings instability index in the Central Forested Region,

INW_t = industrial and export crop earnings instability index in the Western Forested Region,

CD_t = diversification index as defined in equation (1),

**** = b-coefficient significant at the .5 percent level,

- *** = b-coefficient significant at the 1 percent level,
- ** = b-coefficient significant at the 5 percent level,
- * = b-coefficient significant at the 10 percent level,
- () = values in parentheses are standard errors,
- $\bar{R}^2$ = adjusted coefficient of determination.

The procedure yields a set of significant results across regions. These results indicate that there is a strong negative relationship between diversification and the patterns of instability in industrial and export agricultural earnings in the forested zone as well as in its subregions. With the exception of the Western Forested Region, all the coefficients across the forested zone and the other two subregions were statistically significant at the 10 percent level. The Durbin-Watson statistics indicate that the test for the first order autoregressive errors at the 1 percent level shows no serial correlation in the disturbances in all regions and subregions. The economic implication of these negative coefficients is that diversification reduced the pattern of earnings instability. Thus, diversification as a counter instability measure appears to be an appropriate policy for the forested region.

The second aspect of Objective 3 deals with the effect of crop associated earnings diversification (crop income shares) (Table B-3) among regions. This objective was met by regressing the earnings diversification indices of Table B-3 against the earnings instability indices of Table B-1 (equation 8). For the forested zone and each subregion both linear (equation (10)) and quadratic functions (equation (11)) were estimated. On the basis of $\bar{R}^2$, the quadratic function provided the best fit in only the Western Forested Region. The results from these procedures are shown below.

Forested Zone:

$$\begin{aligned} \text{INF}_t &= 8.121^{****} - .056\text{ED}_t^{****} \\ &\quad (1.41) \quad (.011) \\ \bar{R}^2 &=.62; \quad \text{D.W.}=1.99; \end{aligned}$$

Eastern Forested Region:

$$\begin{aligned} \text{INE}_t &= 4.744^{****} - .027\text{ED}_t^{***} \\ &\quad (1.24) \quad (.009) \\ \bar{R}^2 &=.33; \quad \text{D.W.}=1.59; \end{aligned}$$

Central Forested Region:

$$\begin{aligned} \text{INC}_t &= 3.875^{****} - .043\text{ED}_t^{**} \\ &\quad (1.08) \quad (.015) \\ \bar{R}^2 &=.30; \quad \text{D.W.}=1.33; \end{aligned}$$

Western Forested Region:

$$\begin{aligned} \text{INW}_t &= 3.078^{****} - .119\text{ED}_t^{**} + .001\text{ED}_t^{2**} \\ &\quad (.868) \quad (.055) \quad (.0006) \\ \bar{R}^2 &=.20; \quad \text{D.W.}=2.30; \end{aligned}$$

where,

INF_t , INE_t , INC_t and INW_t are industrial and export crop earning instability indices as previously defined,

ED_t = earnings diversification index as defined in equation (10),

**** = b-coefficient significant at the .5 percent level,

*** = b-coefficient significant at the 1 percent level,

** = b-coefficient significant at the 5 percent level,

* = b-coefficient significant at the 10 percent level,

() = values in parentheses are standard errors,

$\bar{R}^2$ = adjusted coefficient of determination.

Results indicate that earnings diversification (evenness in crop income share) is an effective means of alleviating the degree of year-to-year agricultural earnings variability. The Durbin-Watson statistics show that the test for the first order autoregressive errors at the 1 percent level indicates no serial correlation in the disturbances in the forested zone and its three subregions. For the forested region and its eastern and central subregions, the results indicate a negatively significant relationship between earnings diversification and year-to-year earnings instability, at the .5, 1, and 5 percent levels, respectively. For the Western Forested Region, the results show that the diversification process (ED_t) has a negatively significant impact on year-to-year earnings instability, but that beyond a certain range, the earnings diversification process (ED_t^2) positively affected earnings instability. These results for the Western Forested Region provide important insights into the economics of diversification process, since this region was found to register the most rapid rate of diversification. Specifically, the negative coefficient of the diversification variable (ED_t), as well as the positive coefficient of the quadratic term (ED_t^2), register a high level of statistical significance (at the 5 percent level). The implication of this functional form is that the pursuit of the diversification program could result in a crop mixture in which the crop prices may be highly and positively correlated. As such, the proceeds from individual crops would tend to move together. Under these circumstances, diversification could contribute positively to some degree of agricultural earnings instability in the Western Forested Region.

Agricultural Growth and Income Distribution in
the Forested Zone

In meeting Objective 4 of the study, the analysis is focused on agricultural income growth and income distribution characteristics of the study areas.

Agricultural Growth

Table 21 shows that rural population and agricultural income in the forested zone and its subregions all grew at an active pace over the 1965-80 period. These figures are indications that the forested zone and its subregions experienced growth in their agricultural economies. In the forested zone as a whole, total agricultural income grew at an annual rate of 4.6 percent over the 1965-80 period, whereas the total rural population increased at a relatively smaller annual rate of 3.6 percent over the same period. For the Eastern Forested Region, the rural population grew at a much higher rate than the agricultural income from 1965 to 1980. Therefore, the real per capita income in this subregion experienced a decline over the same period. In the Central and Western Forested Regions, rural populations increased annually at 4.4 and 1.8 percent, respectively, over the 1965-80 period. Total agricultural incomes for these two subregions expanded annually at 7.2 and 4.2 percent, respectively, from 1965 to 1980. The annual growth rates of total agricultural incomes were consistently higher than the annual growth rates of rural populations for the forested zone, its central and western subregions over the 1965-80 period. This situation resulted in positive annual growth rates in agricultural per capita incomes for the forested zone, the Central and Western Forested Regions over the period. Given that in the forested zone about 90 percent of

Table 21. Estimates of the total rural population, agricultural income and per capita income in the forested zone and its subregions, Ivory Coast, selected years, 1965-1980

Regions	Rural population				Total agricultural income in 1965 CFAF				Agricultural per capita income				
	1965		1980		1965		1980		1965		1980		
	persons	growth rate 1965-80	persons	growth rate 1965-80	millions CFAF	percent	millions CFAF	percent	constant CFA francs	percent	constant CFA francs	percent	
Forested	1,987,800	3.6	2,807,569	3.36	43,350	4.6	53,889	4.6	9.4	21,808	1.0	24,952	5.6
Eastern Forested	796,600	4.2	1,187,942	4.15	24,179	2.6	25,572	2.6	6.8	30,353	-1.6	21,527	2.5
Central Forested	605,400	4.4	922,962	4.4	12,409	7.2	21,342	7.2	10.5	20,497	2.8	23,124	6.0
Western Forested	585,800	1.8	696,665	1.8	6,762	4.9	6,975	4.9	14.7	11,543	3.1	10,013	12.7

Source: Computations based on data in [4,8,27,32].

the overall rural population is on the farm, it can be argued that the total agricultural income in the forested zone and its two subregions actually grew at much higher rates than the rural populations on the farm. This would suggest that the agricultural economy of the forested zone experienced some increases in productivity of the various primary factors of production, such as labor, capital and land. The data, however, do not permit any definitive statement as to the extent to which this implied increases in labor productivity and other factors were associated with the observed harvest period labor shortages reported by the Ministry of Planning [39]. This situation notwithstanding, there is strong evidence suggesting that factors such as hybrid plants and seeds, fertilizer and pesticide, machinery and irrigation facilities are factors underpinning the relative improvement of labor and other factor productivity, and hence the growth of the agricultural sector of the forested region and its subregions.

Income Distribution Pattern

Table 22 shows the results of equation (12) which is used to evaluate the level and trends in income distribution in the forested zone and its subregions. The maximum value of the inequality index in equation (12) is $\log 3$ which is the logarithm of the total number of regions studied. As such, the maximum index value is 1.09861 which represents the highest degree of income inequality. Data in Table 22 suggest that significant reductions occurred in the degree of inequality in distribution of income in the forested zone over the 1965-80 period. The overall forested region (OFRI) income inequality index registers a level of 0.24103 in 1980, which translates into a 49.2 percent improvement over the 1965 level. Of this 49.2 percent income

Table 22. Income distribution index partitioned into its components as derived in equation (12), total changes and rates of change in the forested zone, Ivory Coast, selected years, 1965-1980

Indices	1965	1975	1980	Total change		Annual rate of change	
				1965-75	1975-80	1965-80	1975-80
	-----natural number-----			-----percent-----			
Between region index (BRI)	0.06742	0.04393	0.01809	35.0	58.8	73.2	16.2
Within region index (WRI)	0.40746	0.39436	0.22294	3.2	43.5	45.3	10.8
Overall forested region index (OFRI)	0.47488	0.43829	0.24103	7.7	45.0	49.2	11.3
						0.8	4.4

enhancement which occurred over the 1965-80 period, only 7.7 percent occurred over the 1965-75 period. The improvement rates of the income inequality index were 0.8 and 4.4 percent, respectively, over the 1965-75 and 1965-80 periods.

From 1965 to 1980 the between subregion (BRI) income inequality index improved 73.2 percent over the 1965 level. Of this 73.2 percent improvement, 35 percent occurred between 1965 and 1975, whereas the remaining 38.2 percent took place over the 1975-80 subperiod. The annual rates of improvement of the BRI were 4.2 percent from 1965 to 1975, and 8.4 percent over the 1965-80 period. For the within subregion (WRI) income inequality index, the 1980 level represents a 45.3 percent improvement over its 1965 level. Only 3.2 percent of this 45.3 percent improvement occurred over the 1965-75 period. Over this subperiod, the WRI only improved at an annual rate of 0.3 percent. However, this rate increased to a value of 3.9 percent over the 1965-80 period. These findings suggest that a significant proportion of the improved agricultural and subsistence income distribution which occurred in the forested zone and its subregions occurred over the 1975-80 period. This observation is borne out by the fact that the BRI, WRI and OFRI improved at annual rates of 16.2, 10.8 and 11.3 percent, respectively, over the 1975-80 period (Table 22). These findings, in conjunction with findings of relatively high levels of the total agricultural and subsistence income annual growth rates in the region and subregions (Table 21), strongly support the contention that growth of the agricultural economy was a concomitant part of the improvement in income distribution in the forested zone and its subregions. Furthermore, it appears from Table 22 that the BRI improved consistently at a faster pace than the WRI and the

OFRI over the 1965-80 period. For the overall forested zone, improvements in its inequality index rates were in turn consistently superior to those experienced by the WRI throughout the 1965-80 period. Although findings in Table 22 indicate that the between subregion (BRI) income inequality was improving at an active pace, results in Table 23 clearly suggest that the 1965-80 subregional income distributional structure was to some extent biased toward the Eastern and Central Forested Regions, at the expense of the Western Forested Region. Although the absolute levels of population and income increased in all the three subregions (Table 21), there are indications (Table 23) that the population and income shares of the Eastern and Western Forested Regions moved in opposite directions, whereas the Central Forested Region population and income shares moved together, though at a different pace. The Eastern Forested Region share of the forested zone rural population increased from 40.0 to 43.0 percent over the 1965-80 period, whereas its share of the forested zone agricultural and subsistence income declined from 56.0 to 42.0 percent over the same period. For the Central Forested Region, its share of the forested zone population increased from 30.0 to 34.0 percent over the 1965-80 period, whereas its share of the overall forested zone income soared from 29.0 to 42.0 percent over the same period. In the case of the Western Forested Region its share of the population in the forested region declined from 30.0 percent in 1965 to 23.0 percent in 1980, whereas its income share of the total income generated in the forested zone only increased from 15.0 to 16.0 percent over the period.

An interesting aspect of these findings is that the earlier years skewness in the income distributional structure toward the Eastern

Table 23. Subregional population and income shares of the forested zone population and income, Ivory Coast, selected years, 1965-1980

Year	Population share			Total	Income share			Total
	Eastern Forested Region	Central Forested Region	Western Forested Region		Eastern Forested Region	Central Forested Region	Western Forested Region	
-----percent-----								
1965	40.0	30.0	30.0	100.0	56.0	29.0	15.0	100.0
1975	42.0	33.0	25.0	100.0	47.0	40.0	13.0	100.0
1980	43.0	34.0	23.0	100.0	42.0	42.0	16.0	100.0

Source: Computations based on data in [4,8,27].

Forested Region appears to be shifting towards the Central Forested Region. In 1965, the Eastern Forested Region with 40.0 percent of the population received 56.0 percent of the income, whereas the Central Forested Region and Western Forested Region, each with 30.0 percent of the population, received 29.0 and 15.0 percent of the income respectively. By 1975, the 42.0 percent of the Eastern Forested Region population received 47.0 percent of the regional income. On the other hand, the 33.0 and 25.0 percent of the rural population in the Central and Western Forested Regions received 40.0 and 13.0 percent of the regional agricultural and subsistence income. The 1980 data indicate that the eastern forested subregion, with 43.0 percent of the regional population, received 42.0 percent of the regional income, whereas the 34.0 and 23.0 percent of the regional population in the central and western subregions received 42.0 and 16.0 percent, respectively, of the regional income. In light of the 1980 data, it appears that the Central Forested Region, the most specialized subregion of the forested zone, has been consistently increasing its income share over the 1965-80 period. On the other hand, the Western Forested Region, the subregion which experienced the most accelerated pace of crop diversification, especially over the 1970-80 subperiod, has exhibited relatively low regional income shares over the 1965-80 period. This situation could mainly be associated with the fact that many of the plantations established in the region have not yet reached their full production stage. Therefore, the full impact of diversification could not be significantly reflected at the regional income share level over the 1965-80 period.

In an attempt to assess the strength of the income distribution procedure applied in equation (12), the Gini coefficient, an alternate

and widely used income distribution indicator, was formulated as shown in Appendix D. It should be recalled, however, that in formulating the Gini index procedure, the income inequality measurement cannot be partitioned into its components. Therefore, the findings as shown in Table 24 only provide information about the agricultural income distribution pattern in the forested zone as a whole, and not its subregions, over the 1965-80 period. Recall that the maximum value of the Gini index is 1.0, which corresponds to the maximum level of income inequality. Its minimum value is zero, which indicates that income is equally distributed among the various groups of individuals in the population.

Results from the Gini concentration ratio procedure indicate that the income distribution structure in the forested zone improved 30.6 percent over the 1965-80 period. Of this 30.6 percent, 10.7 percent of the improvement occurred between 1965 and 1975, whereas the remaining 19.9 percent took place between 1975 and 1980. In terms of annual rate of improvement, the income distribution structure improved at an annual rate of 2.4 percent over the 1965-80 period, 1.1 and 4.9 percent over the 1965-75 and 1975-80 subperiods, respectively. These rates substantiate the findings from equation (12) that the greatest improvement in the forested zone agricultural income distribution over the 1965-80 period occurred over the 1975-80 subperiod.

Summary

Findings from the procedures used to investigate the degree and trend of crop diversification in the forested zone indicate that this region and its three subregions, experienced increases in their levels of diversification over the 1960-80 period. However, the degree of

Table 24. Gini income concentration indices^a in the forested zone, Ivory Coast, selected years, 1965-1980

1965	Years		Total change		Annual rate of change	
	1975	1980	1965-75	1975-80	1965-75	1975-80
-----number-----percent-----						
.07297	.06514	.05062	10.7	22.3	1.1	2.4

^aComputed from the Gini concentration index procedure as specified in Appendix D.

diversification was found to be higher in the Eastern Forested Region than in the Central and Western Forested Regions as well as in the forested zone itself. Results strongly suggest that, within a certain range, industrial and export crop diversification is working against high levels of earnings from the targeted crops, but beyond this range the diversification process would result in increases in levels of earnings from these crops in the forested zone as a whole and in its subregions. The findings further indicate that with the exception of the Western Forested Region, diversification is a means of reducing the magnitude of variability in agricultural earnings. Also, the diversity in the source of earnings resulting from crop diversification appears to be working against earnings instability. However, with the exception of the Western Forested Region, no definitive statement can be made regarding the effects of earnings diversification on earnings instability beyond a certain range. These findings suggest that diversification as a means of reducing earnings instability should be used with flexibility across the forested zone.

In terms of agricultural growth and income distributions, results indicate significant regional and intra-regional reductions in inequality during the 1965-80 period. However, a greater share of the enhancement in the income distributional patterns appear to have occurred in the 1975-80 subperiod. The Gini concentration ratio used as an alternate measure of income distribution in the overall forested region strongly supports the findings from the information theory procedure.

CHAPTER VI
AGRICULTURAL GROWTH AND AGRICULTURAL
DIVERSIFICATION: POLICY DIMENSIONS

Scope of Diversification

The Ivorian approach to diversification has been one of specifying acreage and production target levels for the various export and industrial crops designated in the national diversification programs [38,39]. The 1971-75 and 1976-80 development plans indicate that agricultural diversification objectives were to be achieved by a combination of mechanisms involving (a) acreage expansion, (b) expansion in the production of export, industrial crops and selected food crops, and (c) the development of new lines of production and improvement in old lines. The direct objectives of the combined program mechanisms were to increase income level and stability and improve income distribution. The various development plans do not specify any optimum diversification level that would be consistent with the most stable income level. An "evenness" of crop acreage allocation is achieved when the diversification index for the seven crops studied reaches a value of $\log 7$ which is 1.946. Based on this finding, it can be said that, although the changes in diversification of the forested zone and its subregions exhibit a positive trend, the process is far short of reaching its limit in the respective regions. Given this condition, and the downward stickiness of the administered prices for traditional export crops such as coffee and cocoa, there might not exist a sense of urgency for crop diversification at the farm level. If such a situation

exists, it could suggest that long-run macroeconomic objectives of the government might be constrained by short-run microeconomic objectives at the farm enterprise level. One policy implication of this situation is that the government would have to pursue a more aggressive diversification program in which close attention would have to be given to the effects of pricing policies on the relative rates of return to investment in traditional export crops vis-a-vis new crops.

The comparatively slow pace of diversification occurring in the Central Forested Region (Table 18) could be related to the phenomenon noted above. In addition, it could also be related to the binding nature of the land constraint in some departments within this subregion. According to the Ministry of Planning [28,29,30,31], of the more urbanized departments of the Central Forested Region, such as Daloa, Divo, Gagnoa and Bouafle, only the Daloa, Divo, and to a lesser degree the Bouafle departments (Figure 3), appear to be experiencing elements of dynamic economic growth. Departments such as Gagnoa and its adjacent regions are facing adjustment difficulties related to the extensive nature of farming and the aging of coffee plantations. In the Eastern Forested Region, the most diversified region (Table 18), departments associated with urban centers such as Abengourou, Agboville and Dimbokro (Figure 3) appear to be encountering problems similar to those experienced in the Central Forested Region. In Abengourou and its adjacent areas, the policy of growth based on the expansion of coffee and cocoa hectareage, at the expense of improved crop yields, has apparently reached the limit of land constraint. There appears to be an aging coffee and cocoa tree problem in the Agboville area. This situation is complicated by the adjustment problems associated with the

recent stagnation of the banana and pineapple industries which were developed as a part of the regional diversification program [28,29,31].

The question of the degree of diversification at the national, regional, departmental and farm levels, by necessity, must be evaluated in terms of land, capital and labor availability. In a broader sense, the question must also be evaluated within the context of the demand (both domestic and international) for the products and of the adequacy of the physical, institutional and administrative infrastructural support necessary to effectively complement the process. With respect to the question of resource availability, it would appear that the positive changes in agricultural income associated with the 1960-80 diversification process are attributable, to a large extent, to infusion of greater quantities of both new and improved inputs into the regional agricultural economies. With respect to facilitating infrastructural support, there is ample evidence that the successful transfer of the diversification phenomena between geographical regions was greatly facilitated by a comprehensive network of program-directing government agencies as well as the development of an interregional transportation network in the forested zone. The new economic environment created by these developmental components are major factors associated with the positive gains made in the reduction of income and population disparities in the forested region.

From a policy standpoint, one critical question confronting the Ivorian government is that relating to the degree to which the existing diversification program has achieved optimal or suboptimal levels with respect to the meeting of policy objectives. The empirical findings of this study show that the diversification process improved in the same

direction as the distribution of earnings sources (Table B-3). Also, a greater average earnings stability in the regions studied (Table B-2) and significant improvements in the income distribution structure of the regions (Tables 22 and 24) were achieved over the study period. Given these findings, the evidence is strong that the diversification process has made some progress towards meeting policy objectives. This evidence notwithstanding, there is also some evidence suggesting that the Ivorian diversification program has not reached levels consistent with the program objectives across the forested zone.

One evidence supporting the latter conclusion is the fact that the estimated crop diversification indices for the various study regions (Table 18) are still far short of attaining their maximum diversification value of 1.946. A second evidence is the fact that, with the exception of the Central Forested Region, the coefficient for the quadratic term of crop diversification (CD_t^2) from equation (4) registered a positively significant impact on earnings, whereas the coefficient for the linear term (CD_t) registered a negatively significant impact across all regions. In the Central Forested Region, diversification had little effect on agricultural earnings. A third evidence is the fact that the coefficient for the quadratic term of earnings diversification (ED_t^2) from equation (11), registered a positively significant impact on year-to-year earnings instability for only the Western Forested Region. This means that it was only in the case of this region that crop diversification beyond a critical level would result in a tendency to increase year-to-year earnings instability. No conclusion could be drawn for the other regions, since the coefficients were statistically non-significant.

The implication of these findings for Ivorian diversification policy is that the crop diversification program should be maintained and strengthened as a growth, equity and developmental mechanism. Programs aimed at reviving the economically depressed areas within the forested region should be developed as a complementary package to the diversification program. Departments experiencing old age plantation problems should be the target of plant regenerating programs. The uprooting of old coffee and cocoa trees in those departments will give a unique opportunity to introduce not only high yielding coffee and cocoa varieties, but also new lines of crops, suitable for intensive type of production. Such programs would ultimately relax the land constraint to growth in regions where there is a problem. Given that old coffee and cocoa tree removal is not a cost free action at the farm level, the programs should involve some compensation scheme to make the operations more appealing to the plantation owners. This should be an integral part of the relentless efforts to pursue diversification, coupled with efficiency in the use of arable land resources.

Constraints to Diversification

The long-term success of the diversification program will depend in no small measure on the ability to develop and sustain the productivity of alternative crops to traditional export crops. This suggests that the technical, educational, economic and structural problems involved in the introduction and development of alternative crops must be accorded high priority in the diversification strategy. It is clear that more farmers are growing coffee and cocoa than the designated alternatives (cocunut, banana, pineapple, oil palm and rubber). However, as shown on Figures 4 and 5, despite a positive trend in the earnings of some

alternative crops, the gaps between coffee and cocoa earnings, and those from coconut, banana, pineapple, oil palm and rubber are large. If such a trend were to continue, it could pose a serious long-term constraint to the further adoption of alternative crops at the farm level. To effectively counter such a potential problem a number of steps will have to be taken. Among such steps would be the ability to supply in adequate quantities on a time basis secondary inputs (fertilizer, pesticides, water and technical assistance) and the establishment of a positive and competitive pricing policy for alternative crops in association with adequate marketing facilities. In addition, efforts should be directed to the improvement of land, labor and capital productivity in the production of the new crops. Improved and sustained productivity of these crops will generate rates of return to inputs, used to produce these crops, that are comparable or higher than those used to produce traditional export crops. Such an effort will forestall the situation of a long-term comparative advantage of the traditional crops over the alternative crops. The long-run comparative advantage of traditional crops over new crops has been identified as a major factor associated with the failure of the crop diversification program in Ghana [11]. The Ghana study found that governmental efforts to diversify the agricultural economy away from cocoa production failed primarily as a result of the magnitude of the gap between rates of return to factors of production in cocoa cultivation and those of the next best alternative crops. A similar situation to Ghana's has been reported for Argentina [9]. The Argentina survey found that most manufactured goods in Argentina cost up to three times more to produce than they would in the advanced industrial countries. However, livestock products of the very

highest quality remain the product that the country produces best and most cheaply. As such, it was found that the comparative advantage in Argentina's livestock industry has imposed a major constraint to attempts to diversify the economy away from the livestock subsector.

In light of the importance of the relative rates of return to factors of production in determining the long-term competitive position of new crops, an attempt was made to estimate comparative income generating capacity of traditional and new crops at the 1980 price level. These estimates are presented in Table 25, and summary ranking according to selected criteria are presented in Table 26. Estimates are presented for coffee and cocoa (the two traditional export crops) and for coconut, oil palm and rubber, three of the five new crops involved in the diversification program. Data availability did not permit the inclusion of banana and pineapple in the computations. In spite of this shortcoming, the estimates permit a four-way classification of the major crops according to the value added by labor, returns to land, returns to labor and income generated by each crop at the individual or family unit level. Estimates of value added are based on the assumption that new improved high yielding varieties of the five crops are used.

In terms of net value per hectare, Table 25 shows that coffee yields the greatest value, followed by cocoa. For the new crops, the highest net value per hectare is derived from rubber (third), oil palm (fourth) and coconut (fifth). Classification in terms of return per man day of labor and the value added by labor shows that coffee yields the lowest return per man day among the five crops, whereas the total value added by labor in coffee cultivation is the second highest. Cocoa generates the highest return per man day, as well as the highest value

Table 25. Estimated returns per hectare, man-day, and annual income for a family unit and value added by labor for five of the seven major crops at the 1980 price level, Ivory Coast, 1980

Crops	(1) Yield (kg./ha.)	(2) Price (CFAF/kg.)	(3) Gross value (CFAF/ha.)	(4) Cash costs (CFAF/ha.)	(5) Net value (CFAF/ha.)	(6) Labor (Man- days/ha.)	(7) Return per man- day in CFAF	(8) Total labor costs (CFAF) ^b	(9) Value added by labor (CFAF/ha.)	(10) Avg. farm area per individual or family unit (in ha.)	(11) Avg. annual income for individual or family unit (in CFAF)
Traditional crops:											
Coffee	1,100	300	330,000	28,070	301,930	140	2,157	73,500	228,430	2.60	785,018
Cocoa	1,000	300	300,000	5,100	294,900	84	3,511	44,100	250,800	3.21	946,629
New crops:											
Coconut ^a	21,500	7	150,500	28,750	121,750	50	2,435	26,250	95,500	5.40	657,450
Oil palm (bunch)	15,000	10	150,000	7,875	142,125	52	2,733	27,300	114,825	5.19	737,629
Rubber	1,600	155	248,000	10,650	237,150	81	2,928	42,525	194,625	4.0	948,600

^aYield for coconut is in term of nuts per hectare and price is in terms of CFAF per nut.

^bComputed on the basis of 525 CFAF which represents the average daily wage resulting from the daily wage averages of unsheltered and unfed workers as well as sheltered and fed ones by the farm owners as indicated in [26].

Source: Computations based on data from [26,42,52].

Table 26. Classification of five of the seven crops according to their returns and value added, annual income as computed in Table 25, Ivory Coast, 1980.

Crops	Net value per hectare	Return per man-day	Value added by labor	Annual income for individual or family unit
-----ranking-----				
Traditional crops:				
Coffee	1	5	2	3
Cocoa	2	1	1	2
New crops:				
Coconut	5	4	5	5
Oil palm (bunch)	4	3	4	4
Rubber	3	2	3	1

added by labor. Rubber yields the second highest return per man day, whereas oil palm and coconut are third and fourth, respectively, according to the return per man day criterion. For the value added by labor rubber is third, with oil palm and coconut fourth and fifth, respectively. Ranking on the basis of the average annual income, generated by each crop to an individual or family unit, results in natural rubber producing the largest annual income, followed by cocoa and coffee. With this classification criterion, oil palm and coconut rank fourth and fifth, respectively (Tables 25 and 26).

Results in Tables 25 and 26 suggest that farmers would readily choose to grow cocoa because of its economic advantages over the alternative crops. In the process of choosing the crop to be adopted after cocoa, coffee seems to have the edge over natural rubber. Indeed, even with coffee ranking fifth and third on the return per man day and the annual income criteria, respectively, the long tradition of growing coffee, the relatively short period between establishment and bearing, relative to that of rubber, gives coffee a definite economic edge. The economic advantage of coffee over rubber is also solidified by the relative magnitudes of the total value added and the net value per hectare of the two crops. When these economic characteristics are considered jointly, the conclusion is inescapable that the system is heavily weighted in favor of coffee production at the farm level. The difficulties associated with farm level adjustment away from coffee is also related to the dominant position of the Ivory Coast in the international coffee market. The Ivory Coast ranks third behind Brazil and Colombia in terms of the world's market share of coffee production and exports. In contrast, the country accounts for a minor share of the

highly competitive and volatile international natural rubber market. The level of resource commitment and infrastructural support that permitted this level of market penetration in coffee is one that is not reoriented towards the diversification efforts.

With respect to oil palm and coconut, it can be seen that oil palm consistently ranks above coconut in all four criteria (Table 26). However, unlike coffee and cocoa, oil palm, coconut and rubber are capable of generating a stream of revenue on a round-the-year basis, once they enter the production cycle. This is because these crops can be harvested at a higher frequency than coffee and cocoa. As indicated in Table 25, coffee requires significantly higher levels of labor inputs than the other crops. If the labor productivity in coffee production could be increased, it would not only free up some labor for other types of activities, but it would also increase the value added by labor to coffee production. If such an adjustment should occur, it could enhance the competitive position of new crops. However, it should be expected that such an adjustment would simultaneously increase the income potential of coffee and cocoa, and hence extend the time dimension of the adjustment process.

The relatively favorable rankings of rubber in Tables 25 and 26 coincide with a relatively slow pace of planting and output expansion as indicated by Tables A-6 and A-11. In all probability, this characteristic is indicative of structural bottlenecks in the rubber subsector. If rubber is to be grown successfully under a system of improved technology, it will require managerial skills at the farm level that historically have not been a part of the traditional farming heritage in the forested region. The fact that the bulk of the rubber farms is owned

and operated by a small number of private or semi-private companies suggests that the capital and managerial requisits for commercial rubber production are held by a small group of entrepreneurs. Interestingly enough, there are more villagers involved in growing oil palm than rubber. This phenomenon could be associated with the national policy of placing villagers engaged in oil palm production under the technical and managerial guidance of SODEPALM, the state agency responsible for the development of the oil palm industry.

On the basis of the data in Tables 25 and 26, it would appear that coconut is the least competitive of the five crops evaluated. However, it is conceivable that the relatively low returns to investment on crops such as coconut could partially offset long-term large-scale expansion into high income generating crops with greater year-to-year price instability. There is some evidence that diversification strategy has been a major source of growth and structural change in the agricultural economy of the Ivorian forested region. It also appears that the sustained growth and structural shifts in the regional economy will depend on the extent to which existing and potential economic bottlenecks such as those identified here are eliminated.

Limitations of Diversification

If crop diversification is used as a means of profit maximization, the most profitable level of output then becomes a function of product-product relationships. In a product-product profit maximization situation, the optimum set of crops is chosen by equating the marginal rate of substitution and the inverse price ratios for the competing products. This means that profit is maximized when the marginal value product of a unit of resource allocated to each product (crop) is equal.

However, when diversification is considered as a countervailing measure against uncertainty, the immediate objective is not one of profit maximization, but rather one of income stability. Under this objective, the profit maximization criterion might not be met, or it could become a secondary consideration in the production process. The profit maximization concept could lead farmers to be unwilling to make very important short-term income sacrifices for potential longer-term gains in income stability. It could well be that a substantial number of farmers in the Central Forested Region have made such a production decision which would have led them to a relatively higher degree of specialization in coffee and cocoa in comparison to the two other subregions (Tables 18 and 19). Without overlooking the significance of individual farmer risk aversion, it is clear that if the lowest earnings from coffee and cocoa are consistently greater than the highest earnings from the alternative crops over an extended period of time, farmers will be reluctant to adopt the alternatives. It will be more economically rewarding for them to continue growing and expanding production of these two traditional crops. Under these circumstances, greater variability at a higher level of earnings would seem preferable to a high degree of stability associated with a lower level of earnings. The former situation could, over time, generate a larger mean income to farmers. A large mean income would improve farmers' debt repayment ability, since the lowest mean level of earnings from the pioneering crops (coffee and cocoa) would be greater than or equal to the highest mean level of earnings from alternative crops.

It was suggested in Chapter IV that income variability can be significantly reduced through diversification, if the price, yields or

earnings from the products (crops) bear the proper correlations. Table 27 shows that price correlations for the seven crops are relatively high and positive for the 1960-80 period. This means that there would be some reduction in their ability to stabilize farmers' incomes. In spite of this tendency, they are nevertheless effective in reducing income variability resulting from individual commodity cycles, annual variations in the yields of the individual crops, and some very short-term changes in supply or demand. Because of the nature of Ivorian government price support policy, prices to producers will tend to move upward together and to be rigid downward. This makes Table 27 somewhat less informative than it would have otherwise been, if prices were determined wholly by market forces. In light of these pricing effects, greater considerations were given to output and earnings correlations as a source of useful information on crop combinations more inductive to earnings stability. Table 28 presents the estimated output correlation coefficients for the seven crops studied over the 1960-80 period, and Table 29 shows the earnings correlation coefficients. With respect to output, Table 28 shows relatively lower levels of correlation when compared to those generated by prices (Table 27). This suggests that some of the crop combinations can meaningfully contribute to stabilizing overall output. For example, results from Table 28 indicate that, given the size of the coefficients, the output mixture of coffee, cocoa, banana and oil palm will have a greater stabilizing effect on output than an output mixture of coffee, coconut, pineapple and rubber. This finding suggests that if output stabilization is the objective per se, then only crops such as coffee, cocoa, banana and oil palm with relatively weak correlation coefficients should have been adopted. In

Table 27. Price correlation coefficients for the seven industrial and export cash crops, Ivory Coast, 1960-1980.

Crops	Crops						
	Coffee	Cocoa	Coconut	Banana	Oil palm	Pineapple	Rubber
-----price correlation coefficients-----							
Coffee	1.00000 (21) ^a	0.99008 (21)	0.92260 (21)	0.91787 (21)	0.94419 (21)	0.96054 (21)	0.93198 (20)
Cocoa		1.00000 (21)	0.95024 (21)	0.91826 (21)	0.96786 (21)	0.93641 (21)	0.92673 (20)
Coconut			1.00000 (21)	0.86547 (21)	0.95937 (21)	0.82913 (21)	0.87526 (20)
Banana				1.00000 (21)	0.88150 (21)	0.88440 (21)	0.88693 (20)
Oil palm					1.00000 (21)	0.85943 (21)	0.86795 (20)
Pineapple						1.00000 (21)	0.92303 (20)
Rubber							1.00000 (20)

^aNumbers in parentheses are the number of observations used in deriving the correlation coefficients.

Table 28. Output correlation coefficients for the seven industrial and export cash crops, Ivory Coast, 1960-1980.

Crops	Crops						
	Coffee	Cocoa	Coconut	Banana	Oil palm	Pineapple	Rubber
-----output correlation coefficients-----							
Coffee	1.00000 (21) ^a	0.49466 (21)	0.52075 (21)	0.47401 (21)	0.51703 (21)	0.54328 (21)	0.56294 (20)
Cocoa		1.00000 (21)	0.88659 (21)	0.55398 (21)	0.89355 (21)	0.91332 (21)	0.90645 (20)
Coconut			1.00000 (21)	0.57203 (21)	0.92090 (21)	0.94786 (21)	0.91707 (20)
Banana				1.00000 (21)	0.56946 (21)	0.64011 (21)	0.68953 (20)
Oil palm					1.00000 (21)	0.96615 (21)	0.93854 (20)
Pineapple						1.00000 (21)	0.96798 (20)
Rubber							1.00000 (20)

^aNumbers in parentheses are the number of observations used in deriving the correlation coefficients.

Table 29. Earning correlation coefficients for the seven industrial and export cash crops, Ivory Coast, 1960-1980.

Crops	Crops				
	Coffee	Cocoa	Coconut	Banana	Oil palm
	-----earning correlation coefficients-----				
Coffee	1.00000 (21) ^a	0.94494 (21)	0.85695 (21)	0.90984 (21)	0.90103 (21)
Cocoa		1.00000 (21)	0.87322 (21)	0.90401 (21)	0.92830 (21)
Coconut			1.00000 (21)	0.85244 (21)	0.94400 (21)
Banana				1.00000 (21)	0.92741 (21)
Oil palm					1.00000 (21)
Pineapple					0.92355 (21)
Rubber					0.94198 (20)
					1.00000 (21)
					0.96865 (20)
					1.00000 (20)

^aNumbers in parentheses are the number of observations used in deriving the correlation coefficients.

terms of earnings, a similar reasoning would lead to the suggestion that whether or not an additional enterprise will result in a greater degree of earnings stability will depend largely on both the magnitude and sign of the correlation coefficients between earnings generated by those enterprises. The closer the correlation coefficient values are to -1, the stronger are the indications that additional enterprises will reduce the level of instability in total earnings. In short, earnings correlation coefficients close to zero are more effective in reducing overall earnings variability than those approaching +1; but, they are less preferred than those close to -1. The earning correlation estimates in Table 29 indicate that the two highest correlation coefficients of .97637 and .96865 were derived from the crop mixture of cocoa and rubber, and pineapple and rubber enterprises, respectively. The coefficient between rubber and coffee is also relatively high, with a value of .95752. This value is the fourth highest value, behind that generated by the pineapple and cocoa combination. The lowest correlation coefficient is that derived from the banana and coconut combination. The table further suggests that coffee, combined with coconut, oil palm or even banana would bring about less variable earnings than the coffee and cocoa, coffee and pineapple or coffee and rubber combinations. As far as cocoa is concerned, it seems to be more effective in reducing earnings instability when produced in combination with coconut, banana and oil palm, than when produced in association with pineapple and rubber. The coconut and rubber, and coconut and pineapple combinations appear to be effective in reducing earnings instability. The combined characteristics of the results in Tables 27, 28 and 29 suggest that the relatively high earnings correlation

exhibited among crop combinations are, to a greater degree, associated with the price component of earnings than with the quantity component of earnings.

The Ivorian government will be confronted with massive economic problems in any attempt to arrive at the most optimum earnings stabilizing crop combinations, as suggested by the empirical findings. First, it is economically unfeasible under the structural conditions to expect a single farmer to be able to effectively combine more than two of the seven cropping enterprises studied. Second, the choice of crop combinations is limited in certain regions by crop zoning regulations. For example, crops such as pineapple and banana are restricted under the diversification plans to areas in close proximity to port facilities such as Abidjan. Third, government product market pricing policy has resulted in commodity prices being flexible upwards and rigid downwards. This policy along with governmental factor market subsidies for production of the seven crops constitute a significant built-in price stabilizing component that would tend to work against certain crop combinations.

Role of the Interregional Linkages

Up until the early 1970s, the southwestern region of the forested zone was still physically and economically isolated from the rest of the country. At the present time, this region is well along the way towards the forging of physical and economic linkages with the rest of the forested zone and the country in general. This progress notwithstanding, it is quite obvious that the region is still experiencing spatial inequality problems that are, to a large degree, related to lags in the dynamics of the adjustment process. Regions possess differential

capacity for growth and development. In many instances this characteristic is not recognized when growth and development strategies are conceived at the national level. Regional barriers, whether physical, economic or social, may increase the degree of regional isolation which in turn may impede the diffusion of the growth stimulus for the more progressive regions to the less progressive regions. If such regional barriers did not impose constraints on the transfer of the growth stimulus, the dynamics of interregional factor mobility would overtime tend to reduce per capita income differentials and geographical dualism among regions. However, the pace at which regional inequality is reduced is highly dependent on the magnitude and pace of interregional factor flows between growth oriented and depressed regions. In addition, both the size and the pace of the exogenous growth stimulus must be of a magnitude sufficient to overcome endogenous negative factors in the depressed regions. The observed improvement in the income distributional structure among forested zone subregions can be attributed, among other things, to the forging of interregional economic linkages. These linkages facilitated the diffusion of technological progress and associated agricultural sector productivity gains within regions as well as maximizing the income multiplier effects. Example of such linkages was the completion of the port of San Pedro in the Western Forested Region in the early 1970s, concurrently with the development of a major trans-Central Forested Region road network linking the Eastern and Western Forested Regions. The fact that this period of linkages forging between the subregions of the forested zone coincides with the 1975-80 subperiod, the period of the most dramatic reduction in income inequality between regions, within regions and overall forested zone

during the 1965-80 period (Table 22), strongly suggests that these linkages might have been a major factor in the reduction of regional income disparity. There is strong evidence that the economic payoff to the growth and development process in the forested zone was enhanced because of the continued communication and transportation linkages between the subregions.

In the area of regional labor force participation rate, it should be recognized that interregional migration can have a profound effect on the wage structure of both the labor receiving and labor supplying regions. It should also be recognized that the technological package underpinning the crop diversification program is of a labor demanding nature. This means that the occurrence of labor shortage will adversely affect the ability of the forested zone and its subregions to capture the full benefits of the agricultural growth process associated with new crop combinations. One would expect high labor force participation rates to be associated with higher income regions, whereas the lower income regions would tend to experience relatively low labor force participation rates. Income disparity between geographical regions can be associated with differential labor force participation rates as well as productivity differentials. In terms of the observed income differentials between subregions of the forested zone, the existing data do not permit a definitive statement as to the relative weight of the two factors. It is an accepted fact, however, that high productivity in a sector or subsector will, in all likelihood, be associated with relatively higher labor force participation rates. When sector or subsector productivity levels of a region are high, there is a tendency to have a strong and positive correlation between regional income

levels, productivity levels and labor force participation. This situation appears to be the case for the Eastern and Central Forested Regions in contrast to the Western Forested Region. The net effect is that the two former regions registered persistently higher incomes than the Western Forested Region over the 1965-80 period. In spite of these structural linkages problems, the empirical results suggest that intra-regional growth will be a strong and positive force working against structural rigidities and subregional income disparities.

Summary

The optimal level of agricultural diversification consistent with maximum long-term earnings stability could not be determined by the empirical findings. However, the empirical results suggest that the crop diversification process in the Ivorian forested zone has not reached its technical limit, relative to the seven crops studied. Also, the evidence is strong that significant progress has been made in diversification of the export and industrial crop mixture in the forested zone and its eastern and western subregions. Nevertheless, it appears that departments within the region and the three subregions are experiencing difficulties associated with extensive cultivation practices and aging tree crops. These problems could explain, to some extent, the relatively high degree of specialization found in the Central Forested Region. The question of the scope of the diversification effort that is economically feasible at national, regional, departmental and farm level, is a function of the availability of primary resources such as land, labor and capital. Results suggest that the aggressive forested zone diversification programs are associated with significant declines in average earnings instability and significant

improvement in interregional income distribution. The extent that resource commitment to coffee and cocoa production might be a constraint to development of alternative crops, the removal of low yielding coffee and cocoa trees should offer some opportunity to diversify.

Diversification is not without constraints. Indeed, continuous earnings differentials in favor of traditional export and industrial crops will inhibit progress in diversification. Furthermore, given that banana and pineapple have been restricted to specific areas, the long tradition of growing coffee and cocoa, coupled with the relatively shorter time lag for these crops, between establishment and production vis-a-vis alternative tree crops, could work against crop diversification. This means that appropriate policy measures must be implemented to counteract the comparative disadvantage created for new crops by this biological phenomenon. Diversification also has some limitations when used as a precaution against earnings instability. If over an extended period of time, the lowest average earnings from coffee and cocoa is persistently above the highest earnings from the alternative crops, farmers will find it economically advantageous to continue producing coffee and cocoa and not venture into the production of the new crops. In addition, a high positive correlation between prices, output or earnings of the new crops in a diversification program, can work against the generalized earnings stabilizing tendencies.

Interregional linkages have been and will continue to be a major factor in the improved growth and equity characteristics of the forested zone and its subregions. The establishment of the port of San Pedro in the Western Forested Region and trans-regional transportation and communication networks have significantly contributed to interregional

factor mobility. Increased factor mobility has in turn been associated with a growth generating set of crop combinations and reduced per capita income differentials among subregions. Interregional linkages should be aggressively strengthened and expanded as a complementary factor to the growth and development benefits derived from crop diversification.

CHAPTER VII SUMMARY AND CONCLUSIONS

Summary

The study analyzes levels and trends of industrial and export crop diversification, agricultural earnings instability, and agricultural income distribution in the forested zone of the Ivory Coast, after two decades of an aggressive diversification policy. The economic structure of the forested zone has historically been dominated by the plantation system, involving cocoa, coffee, banana, pineapple and oil palm. The growth of the industrial and export crop subsector in the forested region has been the historical source of national growth and development strategy. The 1971-75 and 1976-80 Development Plans of the Ivory Coast articulated aggressive crop diversification programs involving seven major export and industrial crops in the forested zone. Under the diversification strategy, pioneering crops such as coffee and cocoa were to be grown using high yielding genetic stocks. Banana and pineapple production were to be expanded in geographical regions in close proximity to international shipping facilities. On the other hand, crops such as oil palm, coconut and rubber were to be introduced within a new technological package at the villager farm level through agro-industrial blocks. Although the new lines of crops have been increasing their relative shares in total agricultural production and earnings, in 1980 coffee and cocoa combined still represented 30.4 and 85.3 percent, respectively, of the total quantity and earnings of the

seven crops. Earnings from coffee and cocoa show very high positive trends over the 1960-80 period. However, the earnings from coffee were also vulnerable to a comparatively high degree of year-to-year quantity-induced fluctuations. Data from the Ivorian Ministry of agriculture show that Eastern and Central Forested Regions' coffee and cocoa plantations have continuously dominated regional and national productions of these two export crops. It was hypothesized that the rural per capita income level in the Central Forested subregion might be associated with a relatively high degree of specialization, whereas its counterpart in the eastern forested subregion might be linked with an advanced degree of crop diversification.

The four specific objectives of the study were (a) determination of the degree and patterns of diversification, (b) determination of the impact of diversification on the level of earnings, (c) identification of the impact of diversification on earnings instability, and (d) determination of the incidence of diversification on the income distributional structure of the region and subregions studied. These objectives were met through the development of diversification, instability and income inequality indices which were used in a system of regression analysis based on secondary data. The concept of diversification used in the study was that of "evenness" which emphasizes the extent to which land is being equally allocated among the targeted crops in the area of interest. This concept was more appealing because of the economic implications associated with the allocation of an important resource, such as land, in addition to the fact that the study dealt with a finite number of crops. Of the various measures of income inequality developed by economists, the information theory index was found to be more appealing for the purpose of the study.

Empirical results indicated that the forested zone and its three subregions experienced increases in their relative levels of diversification over the 1960-80 period. However, it was found that the Eastern Forested Region was more diversified than the two other forested subregions. On the other hand, the Central Forested Region appeared to be the most specialized subregion at the end of the study period. The highest rate of growth in diversification was recorded in the Western Forested Region. An alternative measure of diversification, the Herfindahl index, supported the findings from the information theory index on the patterns of diversification in the forested zone and its three subregions.

Except for the Central Forested Region, the econometric relationship between degree of diversification and level of producer earnings indices showed a significant negative linear term and a significant positive quadratic term. These results indicate that as the degree of diversification increased, the level of earnings decreased to a minimum and then increased. With respect to the impacts of diversification on agricultural earning instability, results indicated that the relationship between these two variables was of a negatively significant nature for the forested zone, and its eastern and central subregions. Although the result in the western forested subregion was inconclusive, it nevertheless exhibited the negative relationship between earnings instability and diversification. This result implies that with the exception of the Western Forested Region, diversification could be used as a means to reduce the magnitude of agricultural earnings variability in the forested zone as well as in the Eastern and Central Forested Regions.

Estimates of the effects of earnings diversification via crop diversification on regional and subregional year-to-year earning variability also showed an inverse relationship between the two variables in these regions and subregions. However, these empirical estimates were not statistically significant in the Western Forested Region. As far as the effect of the quadratic term of agricultural earnings diversification on earnings instability is concerned, except for the western forested subregion, the findings failed to be conclusive in the forested zone, as well as in the eastern and central forested subregions. The results in the Western Forested Region indicated that as the agricultural earnings diversification index increased, the earnings instability index first decreased to a minimum and then increased. Trend estimates for growth of the agricultural economy and the income distributional structure in the forested zone suggested that the region and its subregions experienced economic growth and significant improvement in the patterns of income distribution over the study period. The significant enhancement in the income distributional structure was associated with improvements in the between-region, as well as within-region income inequalities. However, the between-region inequality index improved at a higher rate than the within-region inequality index.

In light of these findings, diversification efforts made since the early 1960s were considered to have been economically rewarding. However, it was argued that although trends of diversification are positive in the forested zone, as well as in the three subregions, the persistent higher earnings differentials in favor of coffee and cocoa farmers at the expense of farmers growing the alternative crops, could

be a major constraint to the crop diversification effort at the farm level. Furthermore, high positive correlations between prices, output or earnings of the targeted crops were, among other things, viewed as limiting the stabilizing effects of diversification on agricultural earnings. It was also argued that interregional linkages have been and will continue to be a powerful factor in regional growth and development and reduced regional income disparities. This argument was based on the extent to which improved linkages facilitated interregional factor mobility and growth over the 1960-80 period.

Conclusions

The empirical findings reveal that the forested zone, as well as its three subregions, experienced relative increases in their degree of crop diversification over the study period. The Eastern Forested Region appeared to be the most diversified subregion. Although the pace of diversification was found to be less active in the central forested subregion than in the eastern and western forested subregions, it can be concluded that the diversification efforts undertaken in the Ivory Coast have had some positive economic payoff. Nevertheless, an aggressive diversification policy must be vigorously pursued in order to overcome subregional bottlenecks if the present gains from diversification are to be maintained.

As the level of diversification increased, the level of agricultural earnings first decreased to a minimum and then increased, in the Forested Region and the eastern and western subregions as indicated by the linear and quadratic terms in the estimated regression equations. The lower levels of diversification were associated with the earlier years and the higher levels with the later years in the time

period included in the study. Thus the negative effects may be attributed to early adjustment problems in the establishment of new crops. The concomitant growth in the diversification indices and agricultural earnings, in the eastern and western forested subregions, was viewed as an indication that the earlier years adjustment problems of diversification have in all probability run their course in these two subregions. That is, diversification in these subregions has entered the range in which it is economically rewarding to intensively proceed with it rather than to specialize.

A negative relationship between diversification and agricultural earnings instability was strongly indicated in the forested zone, and the eastern and central subregions. Given the general findings, it was concluded that agricultural diversification was an appropriate policy instrument for reducing agricultural earnings instability in the forested zone and its eastern and central subregions. For the western forested subregion, the results indicated that earning diversification may not permanently inhibit earnings instability in this part of the forested zone. This was perceived as an indication that intensified diversification could result in the adoption of a set of crop enterprises whose prices may be highly and positively correlated. As such, enterprises earnings would tend to move in the same direction, thus introducing earnings instability. In spite of the possibility of this situation occurring, it was felt that this might not emerge as a major problem, given the low value of the positive coefficient.

Estimates of agricultural economic growth trends revealed that except for the eastern subregion, the Ivorian forested zone and subregions experienced substantial growth in both total and per capita

agricultural incomes over the study period. Given that with the exception of the eastern subregion over selected periods, total agricultural income in the forested region and its two subregions consistently grew at much higher rates than those experienced by the rural farm population in general, it was argued that the agricultural economy of the Ivorian forested zone probably experienced some increases in labor productivity. The use of high yielding crop varieties along with higher fertilizer and pesticide use was, among other things, a concomitant part of any improvement in labor productivity. Analysis of the degree and patterns of income distribution in the forested region also revealed that significant improvement occurred in the structure of the regional income distribution over the study period. Since the income distribution inequality index in the forested zone was perceived as the summation of its "between" and "within" region components, it appeared that a greater proportion of the forested zone's improved income distribution came from reduction in the between subregion component as compared to reduction in the within subregion component. This finding was seen as an indication that barriers to the process of reducing income inequality within the forested region (between the various departments) still exist. An interesting aspect of the above findings is that earlier period unbalance in the forested zone subregional income distributional scheme, towards the eastern forested subregion, appeared to be shifting slightly towards the central forested subregion. Such a trend if maintained could be counterproductive for the overall policy of diversification in the forested zone, since it would perpetuate the positive relationship between high level of income and high degree of specialization. The results from the information

theory index of income distribution, in conjunction with those from the Gini index, strongly supported the contention that agricultural growth in the Ivorian forested zone was conducive to improvement in income distribution in that region.

Analysis of structural characteristics such as the extent, constraints and limitations to diversification, provided valuable insights into the long-term policy dimensions of the diversification process. Nevertheless, the level of diversification achieved in the forested region appeared to be associated with meaningful declines in the average earnings instability and a significant improvement in the regional income distribution. However, the persistent high earnings differentials in favor of coffee and cocoa, relative to the alternatives was seen as major constraints to the diversification process. Within this context, it was argued that policies aimed at relaxing the constraints would facilitate the diversification process. On the other hand, if the lowest average earnings from coffee and cocoa were continuously larger than the highest average earnings from the alternative crops, the earnings stabilizing characteristics of diversification would be adversely affected. Furthermore, if a high and positive correlation should persistently exist between prices, outputs or earnings from crop combinations, this could place an additional constraint on the ability of these crop combinations to stabilize farmers' incomes. It was argued that a combination of interregional linkages substantially contributed to the reduction of subregional diversification and per capita income differentials. Therefore, it is suggested that efforts to strengthen those linkages at regional and departmental levels should be aggressively pursued.

It should be emphasized that the study is primarily concerned with diversification, its impacts on agricultural earnings, earnings stability, as well as agricultural income distribution in the Ivorian forested zone and its three subregions. However, since diversification can occur at the national and regional levels, without being experienced at the departmental or farm level, similar studies at farm, subregional and departmental levels could provide valuable information to be used in both identifying constraints at the farm level and designing departmental farm policies. Such information will be useful, given that even within the same ecological environment, farms in adjacent departments may well face structural problems peculiar to their department. Findings from such studies will ultimately result in strengthening the basis of the overall diversification policy in the forested region of the Ivory Coast.

APPENDIX A

TIME-SERIES DATA

Table A-1. Agricultural revenues to producers of the major industrial and export crops grown mainly in the forested zone, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----million CFA francs-----								
1960	13,508	7,797	66	1,743	941	268	--	24,515
1961	15,541	5,613	85	1,790	820	269	10	24,304
1962	9,113	6,043	71	2,052	949	306	18	18,830
1963	16,666	7,083	83	3,022	964	384	62	28,634
1964	22,167	8,184	103	3,168	1,067	466	200	35,658
1965	19,150	8,566	99	2,923	1,031	522	372	33,032
1966	19,992	11,331	127	3,023	1,079	717	517	37,292
1967	14,821	9,636	168	2,491	1,200	959	514	30,783
1968	24,895	10,452	233	2,705	1,189	950	528	42,124
1969	20,613	12,506	267	3,272	1,314	1,057	784	41,286
1970	26,946	14,222	310	3,716	1,792	1,538	900	50,602
1971	25,633	19,927	335	3,944	1,974	1,959	928	55,921
1972	30,145	17,647	380	4,514	2,571	2,649	886	60,745
1973	30,772	18,725	471	3,336	2,670	2,647	1,763	62,514
1974	24,993	34,684	667	4,961	6,961	3,325	2,477	80,718

(continued)

Table A-1. (continued)

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----million CFA francs-----								
1975	40,528	41,898	847	5,944	7,363	3,900	1,928	106,627
1976	49,158	45,826	1,355	4,307	7,459	3,960	2,848	119,491
1977	48,336	55,578	1,417	5,771	8,055	6,153	3,278	134,641
1978	49,090	85,418	1,644	6,077	8,760	9,439	4,171	172,825
1979	66,263	74,702	947	6,321	7,976	9,206	4,828	179,428
1980	80,104	126,262	1,320	7,517	10,797	9,431 ^a	6,250	253,112

^a Estimate based on the assumption that the value to producer of the 1980 pineapple production for the domestic pineapple juice and slices industry remained at its 1979 level.

Source: [22,26,34].

Table A-2. Estimates of the value to producers for the selected crops in the forested zone as a whole, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total ^a
-----million CFA francs-----								
1960	NA	NA	66	1,743	941	268	--	(3,018)
1961	NA	NA	85	1,790	820	269	10	(2,974)
1962	NA	NA	71	2,052	949	306	18	(3,396)
1963	NA	NA	83	3,022	964	384	62	(4,515)
1964	20,857	5,597	103	3,168	1,067	466	200	31,458
1965	15,322	6,908	99	2,923	1,031	522	372	27,177
1966	15,941	5,767	127	3,023	1,079	717	517	27,171
1967	12,333	8,284	168	2,491	1,200	959	514	25,949
1968	21,708	8,478	233	2,705	1,189	950	528	35,791
1969	17,852	9,103	267	3,272	1,314	1,057	784	33,649
1970	22,296	11,927	310	3,716	1,792	1,538	900	42,479
1971	22,797	12,364	335	3,944	1,974	1,959	928	44,301
1972	25,102	15,616	380	4,514	2,571	2,649	886	51,718
1973	27,590	15,279	471	3,336	2,670	2,647	1,763	53,756
1974	23,638	29,127	667	4,961	6,961	3,214	2,477	71,045

(continued)

Table A-2. (continued)

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----million CFA francs-----								
1975	36,689	36,847	847	5,944	7,363	3,419	1,928	93,037
1976	40,471	35,063	1,355	4,307	7,459	3,515	2,848	95,018
1977	45,644	45,508	1,417	5,771	8,055	5,250	3,278	114,923
1978	46,057	65,551	1,644	6,077	8,760	8,171	4,171	140,431
1979	60,337	71,081	947	6,321	7,976	7,833	4,828	159,323
1980	72,405	85,299	1,320	7,517	10,797	8,309	6,250	191,897

^aValues in parentheses do not include earnings from coffee and cocoa for the specific year.

Source: [21,22,23,24,25,26,34].

Table A-3. Estimates of the value to producers for the selected crops in the Eastern Forested Region, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----million CFA francs-----								
1960	NA	NA	--	1,320	--	177	--	(1,497)
1961	NA	NA	--	1,345	--	175	10	(1,530)
1962	NA	NA	--	1,546	--	213	18	(1,777)
1963	NA	NA	--	2,269	--	291	62	(2,622)
1964	12,364	4,338	--	2,377	--	376	200	19,655
1965	8,064	5,037	--	2,194	--	433	372	16,100
1966	8,225	4,337	--	2,272	9	629	517	15,989
1967	6,413	6,067	--	1,861	53	863	514	15,771
1968	12,005	5,823	--	2,068	94	879	528	21,397
1969	7,625	6,084	--	2,557	204	960	784	18,214
1970	12,301	7,306	--	2,932	487	1,387	900	25,313
1971	11,107	6,780	--	3,171	676	1,803	928	24,465
1972	12,435	8,553	--	3,650	1,101	2,478	886	29,103
1973	12,667	7,706	4	2,615	1,190	2,472	1,763	28,417
1974	11,108	13,658	23	3,984	3,640	3,078	2,477	37,968

(continued)

Table A-3. (continued)

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----million CFA francs-----								
1975	18,250	18,034	39	4,378	2,971	3,234	1,928	48,834
1976	19,447	17,868	151	3,041	4,022	3,337	2,848	50,714
1977	21,263	22,719	342	4,032	3,836	4,925	3,278	60,395
1978	17,385	30,758	475	4,380	4,336	7,487	4,116	68,937
1979	21,811	32,796	881	4,480	3,748	7,141	4,800	75,657
1980	26,173	39,356	1,208	5,602	5,781	7,500	6,133	91,753

^aValues in parentheses do not include earnings from coffee and cocoa for the specific year.

Source: [21,22,23,24,25,26,34].

Table A-4. Estimates of the value to producers for the selected crops in the Central Forested Region, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Oil Palm Bunch	Pineapple	Total ^a
-----million CFA francs-----					
1960	NA	NA	--	10	(10)
1961	NA	NA	--	12	(12)
1962	NA	NA	--	13	(13)
1963	NA	NA	--	15	(15)
1964	5,739	1,238	--	19	6,996
1965	5,049	1,807	--	23	6,879
1966	4,934	1,374	--	28	6,336
1967	3,995	2,119	--	32	6,146
1968	6,875	2,539	--	36	9,450
1969	6,849	2,853	10	35	9,747
1970	6,573	4,463	42	57	11,135
1971	7,706	5,372	88	59	13,225
1972	8,658	6,800	181	79	15,718
1973	10,048	7,270	173	81	17,572
1974	7,671	14,971	516	136	23,294
1975	12,917	17,947	472	185	31,521
1976	15,007	16,252	462	178	31,899
1977	15,614	21,650	614	325	38,203
1978	16,523	32,018	660	684	49,885
1979	26,861	34,246	677	692	62,476
1980	32,234	41,096	860	809	74,999

^aValues in parentheses do not include earnings from coffee and cocoa for the specific year.

Source [21,22,23,24,25,26,34]

Table A-5. Estimates of the value to producers for the selected crops in the Western Forested Region, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Oil Palm Bunch	Total
-----million CFA francs-----				
1960	NA	NA	--	NA
1961	NA	NA	--	NA
1962	NA	NA	--	NA
1963	NA	NA	--	NA
1964	2,754	21	--	2,775
1965	2,209	64	--	2,273
1966	2,782	56	--	2,838
1967	1,925	98	--	2,023
1968	2,828	116	--	2,944
1969	3,378	166	16	3,560
1970	3,422	158	18	3,598
1971	3,984	212	20	4,216
1972	4,009	263	85	4,357
1973	4,875	303	132	5,310
1974	4,859	498	452	5,809
1975	5,522	866	416	6,804
1976	6,017	943	616	7,576
1977	8,767	1,139	855	10,761
1978	12,149	2,775	935	15,859
1979	11,665	4,039	894	16,598
1980	13,998	4,847	1,212	20,057

Source: [21,22,23,24,25,26,34].

Table A-6. Total production of the major industrial and export crops grown mainly in the forested zone, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----metric tons-----								
1960	136,635	85,683	2,000	88,000	298,121	19,885	--	630,324
1961	171,832	77,378	2,400	98,000	261,627	19,921	82	631,240
1962	116,813	91,565	2,350	131,300	297,424	22,777	205	662,434
1963	214,587	101,770	2,900	139,400	303,339	29,904	551	792,451
1964	240,946	113,669	3,100	126,000	327,339	41,184	2,045	854,283
1965	212,989	134,060	3,500	138,300	329,300	44,083	3,552	865,784
1966	256,225	162,917	4,400	154,500	318,400	60,840	4,959	962,241
1967	156,823	129,733	5,600	165,400	345,350	83,687	5,857	892,450
1968	267,592	141,485	7,500	174,648	341,117	89,424	6,870	1,028,636
1969	219,046	157,972	8,000	172,194	373,532	89,468	8,656	1,028,868
1970	274,530	167,989	10,300	178,852	480,181	109,605	11,041	1,232,498
1971	240,553	231,871	11,000	188,372	538,574	138,128	13,691	1,362,189
1972	283,242	199,576	11,500	212,288	686,544	202,699	14,536	1,610,385
1973	277,241	179,022	12,500	177,190	685,729	199,425	15,200	1,546,307
1974	198,854	222,676	13,500	207,824	916,102	228,131	16,511	1,803,598

(continued)

Table A-6. (continued)

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----metric tons-----								
1975	268,192	239,418	15,800	192,275	966,951	239,705	16,481	1,938,822
1976	319,683	257,444	20,900	147,190	973,820	267,491	16,852	2,003,380
1977	263,798	243,083	23,290	163,669	855,500	248,702	17,719	1,815,761
1978	196,360	341,674	25,677	196,773	926,000	319,735	18,704	2,024,923
1979	265,052	298,809	14,795	168,611	847,621	296,080	19,284	1,910,252
1980	267,013	420,872	20,622	162,651	1,079,656	289,780 ^a	21,626	2,262,220

^aEstimate based on the assumption that the 1980 pineapple production for the domestic pineapple juice and slices industry remained at its 1979 level.

Source: [22,23,24,25,26,34].

Table A-7. Estimates of productions for the selected crops in the forested zone as a whole,
Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----metric tons-----								
1960	NA	NA	2,000	88,000	298,121	13,831	--	(401,952)
1961	NA	NA	2,400	98,000	261,627	13,858	82	(375,967)
1962	NA	NA	2,350	131,300	297,424	16,707	205	(447,986)
1963	NA	NA	2,900	139,400	303,339	23,898	551	(470,088)
1964	226,710	80,515	3,100	126,000	327,339	34,971	2,045	800,680
1965	170,440	109,660	3,500	138,300	329,300	37,992	3,552	792,744
1966	204,370	82,395	4,400	154,500	318,400	54,700	4,959	823,724
1967	129,870	111,921	5,600	165,400	345,350	77,820	5,857	841,818
1968	233,420	114,572	7,500	174,648	341,117	83,228	6,870	961,355
1969	189,920	115,227	8,000	172,194	373,532	82,958	8,656	950,487
1970	231,850	140,320	10,300	178,852	480,181	103,105	11,041	1,155,649
1971	213,050	143,770	11,000	188,372	538,574	131,128	13,691	1,239,585
1972	236,810	174,450	11,500	212,288	686,544	195,209	14,536	1,531,337
1973	248,560	146,910	12,500	177,190	685,729	191,935	15,200	1,478,024
1974	187,600	186,710	13,500	207,824	916,102	220,131	16,511	1,478,378

(continued)

Table A-7. (continued)

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----metric tons-----								
1975	242,970	210,555	15,800	192,275	966,951	209,705	16,481	1,854,737
1976	262,800	196,980	20,900	147,190	973,820	237,491	16,852	1,856,033
1977	249,415	198,725	23,290	163,669	855,500	218,746	17,719	1,727,064
1978	184,225	262,200	25,677	196,773	926,000	284,696	18,704	1,898,275
1979	241,348	284,325	14,795	168,611	847,621	261,068	19,284	1,837,052
1980	241,378	284,325	20,622	162,651	1,079,656	254,876	21,626	2,065,104

^aValues in parentheses do not include coffee and cocoa production for the specific year.

Source: [20,21,22,23,24,25,26,41,42,43].

Table A-8. Estimates of productions for the selected crops in the Eastern Forested Region, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----metric tons-----								
1960	NA	NA	--	66,000	--	13,093	--	(79,093)
1961	NA	NA	--	73,500	--	12,995	82	(86,577)
1962	NA	NA	--	98,475	--	15,750	205	(114,430)
1963	NA	NA	--	104,550	--	22,715	551	(127,816)
1964	134,390	63,030	--	94,500	--	33,281	2,045	327,246
1965	89,800	79,950	--	103,725	--	36,092	3,552	313,119
1966	105,450	61,960	--	115,875	2,687	52,400	4,959	343,331
1967	67,500	81,970	--	124,050	13,123	75,020	5,857	367,520
1968	129,090	78,690	--	133,417	23,572	79,928	6,870	451,567
1969	81,120	77,010	--	134,597	51,096	80,018	8,656	432,497
1970	125,520	85,950	--	140,949	121,701	99,055	11,041	584,216
1971	103,800	78,840	--	146,256	169,011	126,958	13,691	638,556
1972	117,310	97,190	--	171,374	275,319	189,149	14,536	864,878
1973	114,120	74,100	115	137,653	297,472	185,845	15,200	824,505
1974	88,160	87,550	473	165,985	454,998	210,851	16,511	1,024,528

(continued)

Table A-8. (continued)

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm Bunch	Pineapple	Rubber	Total
-----metric tons-----								
1975	120,860	103,050	732	141,213	371,424	198,375	16,481	952,135
1976	126,280	100,380	2,331	101,365	502,803	225,501	16,852	1,075,512
1977	116,190	99,210	5,623	114,213	383,597	205,209	17,719	941,761
1978	69,540	123,030	7,417	141,303	433,554	260,858	18,457	1,054,159
1979	87,242	131,185	13,752	119,470	374,760	238,019	19,195	983,623
1980	87,242	131,185	18,867	121,000	578,130	230,062	21,222	1,187,708

^aValues in parentheses do not include coffee and cocoa productions for the specific year.

Source: [20,21,22,23,24,25,26,41,42,43].

Table A-9. Estimates of productions for selected crops in the Central Forested Region, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Oil Palm Bunch	Pineapple	Total ^a
-----metric tons-----					
1960	NA	NA	--	738	(738)
1961	NA	NA	--	863	(863)
1962	NA	NA	--	957	(957)
1963	NA	NA	--	1,183	(1,183)
1964	62,380	17,200	--	1,690	81,270
1965	56,100	28,690	--	1,900	86,690
1966	63,250	19,630	--	2,300	85,180
1967	42,050	28,630	--	2,800	73,480
1968	73,920	34,310	--	3,300	111,530
1969	72,860	36,120	2,400	2,940	114,320
1970	69,930	52,510	10,579	4,050	137,069
1971	72,020	62,470	22,039	4,170	160,699
1972	81,680	77,270	45,133	6,060	210,143
1973	90,520	69,900	43,265	6,090	209,775
1974	60,880	95,970	64,538	9,280	230,668
1975	85,540	102,555	59,034	11,330	258,459
1976	97,450	91,305	57,718	11,990	258,463
1977	85,320	94,540	61,409	13,537	254,806
1978	66,090	128,070	65,966	23,838	283,964
1979	107,445	136,985	67,646	23,049	335,125
1980	107,445	136,985	86,036	24,814	355,280

^aValues in parentheses do not include coffee and cocoa productions for the specific year.

Source [20,21,22,23,24,25,26, 41,43].

Table A-10. Estimates of productions for selected crops in the Western Forested Region, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Oil Palm Bunch	Total
-----metric tons-----				
1960	NA	NA	--	NA
1961	NA	NA	--	NA
1962	NA	NA	--	NA
1963	NA	NA	--	NA
1964	29,940	285	--	30,225
1965	24,540	1,020	--	25,560
1966	35,670	805	--	36,475
1967	20,260	1,321	--	21,581
1968	30,410	1,572	--	31,982
1969	35,940	2,097	3,900	41,937
1970	36,400	1,860	4,425	42,685
1971	37,230	2,460	5,020	44,710
1972	37,820	2,990	21,291	62,101
1973	43,920	2,910	33,068	79,898
1974	38,560	3,190	56,461	98,211
1975	36,570	4,950	51,947	93,467
1976	29,070	5,295	76,943	121,308
1977	47,905	4,975	85,458	138,338
1978	48,595	11,100	93,515	153,210
1979	46,661	16,155	89,442	152,258
1980	46,661	16,155	121,187	184,003

Source: [21,22,24,25,26,43].

Table A-11. Estimates of planted areas for the selected crops in the forested region as a whole, Ivory Coast, 1960-1980

Years	-----hectares-----						
	Coffee	Cocoa	Coconut	Banana	Oil Palm	Pineapple	Rubber
1960	461,100	339,900	6,089	2,200	5,513	244	7,243
1961	479,800	348,150	6,720	2,450	6,310	248	8,077
1962	499,700	357,100	7,416	3,292	7,725	297	8,827
1963	520,300	366,550	8,184	3,485	9,548	422	10,530
1964	542,100	376,750	9,032	3,150	11,561	616	10,887
1965	565,000	387,600	9,967	3,457	14,075	671	11,034
1966	589,130	399,400	11,000	3,862	20,616	968	11,656
1967	614,450	412,000	13,020	4,135	32,125	1,365	12,216
1968	641,260	425,500	15,879	4,447	43,115	1,500	12,764
1969	669,800	440,100	20,413	4,487	53,575	1,487	12,818
1970	698,600	455,950	25,496	4,698	64,884	1,824	12,881
1971	730,800	473,000	27,443	4,875	69,085	2,369	13,142
1972	764,000	491,500	29,562	5,712	70,057	3,582	13,147
1973	1,045,000	811,000	32,917	4,588	73,536	3,573	14,099
1974	1,017,000	730,000	36,167	5,532	75,919	4,194	15,566
							1,884,378

(continued)

Table A-11. (continued)

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm	Pineapple	Rubber	Total
1975	1,050,000	754,500	38,867	4,707	79,738	4,072	17,794	1,949,678
1976	1,085,000	778,500	42,151	3,379	84,220	4,501	20,121	2,017,872
1977	1,118,500	811,000	46,273	3,807	92,803	4,229	23,674	2,100,286
1978	1,181,000	858,500	50,845	4,710	98,127	5,601	27,051	2,225,834
1979	999,250	978,950	51,888	3,982	100,923	5,170	30,418	2,170,581
1980	999,250	978,950	51,888	4,033	100,352	5,015	34,869	2,174,357

Source: [21,22,23,24,25,26,41,44,45,46].

Table A-12. Estimates of the planted areas for the selected crops in the Eastern Forested Region, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Coconut	-----hectares-----				Pineapple`	Rubber	Total
				Banana	Oil Palm					
1960	281,500	274,000	--	2,200	5,183			226	7,243	570,352
1961	290,100	276,400	--	2,450	5,964			226	8,077	583,217
1962	299,000	278,900	--	3,292	7,356			273	8,827	597,648
1963	308,100	281,400	--	3,485	9,159			392	10,530	613,066
1964	317,500	283,950	--	3,150	11,146			574	10,887	627,207
1965	327,200	286,500	--	3,457	13,631			623	11,034	642,445
1966	337,230	289,100	--	3,862	19,314			910	11,656	662,072
1967	347,500	291,700	516	4,135	27,721			1,296	12,216	685,084
1968	358,160	294,300	2,027	4,447	35,002			1,417	12,764	708,117
1969	369,100	296,900	4,246	4,487	41,859			1,413	12,818	730,823
1970	380,000	299,600	7,255	4,698	50,357			1,723	12,881	756,514
1971	392,000	302,300	8,483	4,875	53,803			2,265	13,142	776,868
1972	404,000	305,000	9,902	5,712	53,721			3,430	13,147	794,912
1973	469,000	416,000	11,867	4,588	56,657			3,421	14,099	975,632
1974	429,500	358,500	14,075	5,532	58,545			3,962	14,465	884,579

(continued)

(continued)

Table A-12. (continued)

Years	Coffee	Cocoa	Coconut	Banana	Oil Palm	Pineapple	Rubber	Total
	-----hectares-----							
1975	443,500	367,000	14,941	4,707	61,460	3,789	15,184	910,581
1976	459,000	373,500	17,208	3,379	64,056	4,201	15,659	937,003
1977	473,000	385,000	18,760	3,807	67,481	3,891	16,064	968,003
1978	501,000	405,500	19,337	4,710	69,013	5,005	16,697	1,021,262
1979	403,100	436,300	19,646	3,982	71,785	4,594	17,463	956,870
1980	403,100	436,300	20,030	4,033	71,223	4,395	19,353	958,434

Source: [20,21,22,23,24,25,26,41,45,46].

Table A-13. Estimates of the planted areas for the selected crops in the Central Forested Region, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Coconut	Oil Palm	Pineapple	Total
-----hectares-----						
1960	132,200	63,100	--	--	18	195,318
1961	137,800	68,500	--	--	22	206,322
1962	143,800	74,400	--	--	24	218,224
1963	150,000	80,750	--	--	30	230,780
1964	156,400	87,700	--	--	42	244,142
1965	163,100	95,200	--	--	48	258,348
1966	170,100	103,400	--	843	58	274,401
1967	177,450	112,300	--	2,300	69	292,119
1968	185,100	121,900	--	3,516	83	310,599
1969	193,300	132,400	--	4,705	74	330,479
1970	201,000	143,750	250	5,527	101	350,628
1971	210,000	156,100	392	5,662	104	372,258
1972	219,000	169,500	616	5,897	152	395,165
1973	386,000	349,000	963	6,117	152	742,080
1974	360,000	321,000	1,653	6,383	232	689,268
1975	371,000	333,000	1,673	6,509	283	712,465
1976	382,000	345,500	2,357	7,244	300	737,401
1977	393,000	358,500	2,543	7,457	338	761,838
1978	412,000	381,000	2,806	7,532	596	803,934
1979	339,900	433,950	3,262	7,532	576	785,220
1980	339,900	433,950	3,824	7,532	620	785,826

Source: [21,22,23,24,25,26,41,44,45,46].

Table A-14. Estimates of the planted areas for the selected crops in the Western Forested Region, Ivory Coast, 1960-1980

Years	Coffee	Cocoa	Coconut	Oil Palm	Rubber	Total
-----hectares-----						
1960	47,400	2,800	--	330	--	50,530
1961	51,900	3,250	--	346	--	55,496
1962	56,900	3,800	--	369	--	61,069
1963	62,300	4,400	--	389	--	67,089
1964	68,200	5,100	--	415	--	73,715
1965	74,700	5,900	--	444	--	81,044
1966	81,800	6,900	--	459	--	89,159
1967	89,500	8,000	--	2,104	--	99,604
1968	98,000	9,300	--	4,597	--	111,897
1969	107,400	10,800	116	7,011	--	125,327
1970	117,600	12,600	137	9,000	--	139,337
1971	128,800	14,600	148	9,620	--	153,168
1972	141,000	17,000	164	10,439	--	168,603
1973	190,000	46,000	173	10,762	--	246,935
1974	227,500	50,500	177	10,991	1,101	290,269
1975	235,500	54,500	200	11,769	2,610	304,579
1976	244,000	59,500	2,452	12,920	4,462	323,334
1977	252,500	67,500	5,352	17,865	7,610	350,827
1978	268,000	72,000	7,332	21,582	10,354	379,268
1979	256,250	108,700	7,419	21,606	12,955	406,930
1980	256,250	108,700	7,519	21,597	15,516	409,582

Source: [21,22,23,24,25,26,41,42,45,46].

Table A-15. Agricultural income and rural population in the forested zone and its subregions, Ivory Coast, selected years, 1965-1980

Departments	Rural population		Agricultural income ^a			
	1965	1975	1980	1965	1975	1980
	-----persons-----		-----	-----million CFA francs-----		
Abengourou	63,300	132,483	192,592	3,151	7,346	14,441
Abidjan	235,100	332,043	393,875	6,264	11,814	22,198
Aboisso	63,900	124,339	173,847	2,286	6,579	15,841
Adzope	84,900	113,412	130,358	1,924	5,337	7,623
Agboville	64,700	114,778	152,878	1,560	2,262	3,816
Dimbokro	284,700	370,887	424,565	8,994	13,306	23,121
Total Eastern Forested Region	796,600	1,187,942	1,468,115	24,179	46,644	87,040
Bouaflé	165,000	221,968	257,065	3,746	7,615	17,713
Daloa	152,200	288,355	396,984	2,956	12,125	28,209
Divo	138,500	217,743	271,910	2,643	10,955	26,834
Gagnoa	149,700	194,896	223,243	3,064	8,233	13,627
Total Central Forested Region	605,400	922,962	1,149,202	12,409	38,928	86,383

(continued)

(continued)

Table A-15. (continued)

Departments	Rural population		Agricultural income ^a		
	1965	1975	1965	1975	1980
	-----persons-----		-----million CFA francs-----		
Biankouma	64,500	70,977	473	1,142	2,569
Danané	126,700	150,377	1,757	3,036	7,862
Guiglo	98,300	105,443	1,108	1,800	4,630
Man	213,000	228,344	2,327	4,320	9,051
Sassandra	83,300	141,524	1,097	2,425	9,942
Total Western Forested Region	585,800	696,665	6,762	12,723	34,054
Total Western Forested Region	585,800	696,665	6,762	12,723	34,054
Total Forested Zone	1,987,800	2,807,569	43,350	98,295	207,477

^aThis income is basically made of net earnings from industrial and export crops, food crops, traditional fisheries and firewood.

Source: Computations based on data in [4,8,27].

APPENDIX B

ADDITIONAL FINDINGS FROM THE
OPERATIONAL MODELS

Table B-1. Year-to-year earnings variability index as defined in equation (8) for the forested zone, the Eastern, Central and Western Forested Regions, Ivory Coast, 1964-1980

Years	Forested Region	Eastern Forested Region	Central Forested Region	Western Forested Region
-----percent-----				
1964	2.5000	3.0085	1.8296	3.9059
1965	1.1444	.6941	1.4982	1.0066
1966	1.5869	1.2187	1.9685	1.2517
1967	1.4386	1.0436	2.1929	2.7917
1968	1.4079	1.8290	.7892	.5600
1969	.9543	2.0843	.2950	1.3831
1970	.7854	1.4147	.1027	.2667
1971	.2419	.5860	.1097	1.1971
1972	.8159	1.3162	.5164	.7247
1973	1.3717	1.7050	1.2268	.5338
1974	.0836	.1602	.5631	.2619
1975	.3957	.7225	.4652	.3280
1976	.0160	.5966	.1879	1.9419
1977	.6577	.1880	.3783	2.9388
1978	.0184	.1903	.6454	1.0497
1979	.5263	.7718	.2119	.6255
1980	1.1440	1.1393	1.5828	2.7982

Table B-2. Average earnings variability indices as defined in equation (5) for the forested zone, the Eastern, Central and Western Forested Regions, Ivory Coast, selected years, 1965-1980

Years	Forested Region	Eastern Forested Region	Central Forested Region	Western Forested Region
-----percent-----				
1965	2.7124	2.8561	3.0533	3.6496
1970	1.6961	1.8376	2.0017	2.5372
1975	1.5321	1.6636	1.7055	2.2881
1980	1.3742	1.4670	1.5382	2.2471

Table B-3. Earnings diversification^a indices in the forested zone and its subregions, Ivory Coast, 1964-1980

Years	Forested Region	Eastern Forested Region	Central Forested Region	Western Forested Region
-----percent-----				
1964	103.8875	100.2910	48.4979	4.4498
1965	119.0302	116.5754	59.7223	12.8275
1966	121.0649	112.1557	55.0186	9.6995
1967	131.7353	112.7530	67.4513	19.3905
1968	114.4011	115.0595	60.5766	16.6039
1969	127.7904	134.7251	63.4834	21.7029
1970	127.9368	131.2801	72.5658	21.1456
1971	130.7845	139.4426	73.8162	22.9223
1972	133.2466	142.3521	76.8973	32.2858
1973	132.3368	145.2605	75.5033	33.3715
1974	144.6067	157.4976	76.4330	55.8658
1975	135.4770	143.5328	77.9331	60.2665
1976	135.9102	146.2920	78.8609	64.6390
1977	136.6727	148.2940	79.4473	60.5887
1978	135.2231	150.0276	76.6634	67.6057
1979	129.0283	148.6753	79.1377	74.9129
1980	129.8708	150.8321	79.2664	76.3804

^aEarnings diversification refers to the "evenness" of crop revenue contributions to total earnings. This index is derived from a mathematical formulation similar to equations (1) and (2), but with the dependents variable being earnings diversification, rather than crop diversification and the independent variable being the earning share of individual crop, rather than the proportion of land allocated to individual crop.

APPENDIX C

AN ALTERNATIVE MEASURE OF
CROP DIVERSIFICATION

APPENDIX C

The Herfindahl Index

The Herfindahl index represents a cumulative index where both the number of activities in the setting and the entire size of distribution of those activities are taken into consideration in addition to the share of each activity. The index is a measure of dispersion which value varies between zero and 1. The Herfindahl index can be derived as follows:

Given,

N = number of crops,

L = total size of land under the various crops,

L_i = absolute size of land under crop i ,

l_i = proportion of land under crop i ($l_i = \frac{L_i}{L}$).

The square of the coefficient of variation can be written as

$$CV^2 = \frac{L^2}{L^2} = \frac{\sum_{i=1}^N L_i^2 - NL^2}{NL^2} \quad C-1$$

$$CV^2 = \frac{\sum_{i=1}^N L_i^2}{NL^2} - \frac{NL^2}{NL^2} \quad C-2$$

$$CV^2 = \frac{\sum_{i=1}^N L_i^2}{NL^2} - 1 \quad C-3$$

Transforming the right-hand side of C-3 gives

$$CV^2 = \frac{\sum_{i=1}^N L_i^2}{N \left(\frac{\sum L_i}{N} \right)^2} - 1 \quad C-4$$

with $\sum L_i = L$, L being the fix total size of land at any given period.

Rearranging the right-hand side of C-4 yields

$$CV^2 = N \sum_{i=1}^N \left(\frac{L_i}{L} \right)^2 - 1 \quad C-5$$

replacing $\frac{L_i}{L}$ by its value l_i yields

$$CV^2 = N \sum_{i=1}^N l_i^2 - 1 \quad C-6$$

this in turn gives

$$CV^2 + 1 = N \sum_{i=1}^N l_i^2 \quad C-7$$

and the Herfindahl index in period t is defined as

$$HI_t = \left(\sum_{i=1}^N l_i^2 \right)_t = \left(\frac{CV^2 + 1}{N} \right)_t \quad C-8$$

Hence as the square of the coefficient of variation (CV^2) or the number of crops (N) changes the degree of concentration changes.

(a) if CV^2 increases this translates into an increase of the index.

(b) if N increases this results into a decline of the Herfindahl index,

(c) if now L_i equals $\bar{L}$ then CV will be zero and the index takes on the value $\frac{1}{N}$.

If the Herfindahl index is substantially above $\frac{1}{N}$ and eventually approaches 1, there is then evidence for crop concentration. This will occur as the number of crops approaches 1. However, if the index is in the neighborhood of $\frac{1}{N}$, then there is an indication that crop diversification is taking place.

In order to identify the patterns of crop concentration over time, the following exponential trend procedure was used.

$$HI_t = Be^{\beta T} \quad C-9$$

where,

HI_t = crop concentration index in period t as set up in equation (C-8),

B = scale of crop concentration.

β = rate of growth of crop concentration, and

T = time trend.

Results from equation C-8 will enable the computations of the parameters B and β from the exponential trend procedure defined in equation C-9.

APPENDIX D

AN ALTERNATIVE ESTIMATING PROCEDURE
OF INCOME INEQUALITY

APPENDIX D

The Gini Measure of Income Inequality

The Gini concentration ratio is used in the present study as an alternative measure of income inequality in the forested zone as a whole to see if it yields results that support the findings from the information index measure of inequality.

The Gini index as used in this study may be defined as follows:

Considering N groups of individuals in the rural areas of the forested zone,

with X_i = the population share of the i^{th} group, and

Y_i = the income share of the i^{th} group, thus the Gini coefficient in period t was set as:

$$G_t = \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^n |X_i Y_j - X_j Y_i| \quad \text{D-1}$$

which can be written as

$$G_t = \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^n X_i X_j \left| \frac{Y_i}{X_i} - \frac{Y_j}{X_j} \right| \quad \text{D-2}$$

Hence, as it can be seen from equation D-2, the Gini measure of income inequality is one-half of a weighted average of the absolute differences between the deflated per capita incomes. The weights are the products of the corresponding population shares. The maximum value of the index is 1 which is reached when one group of individuals gains

all the income, while the other groups earn nothing. The minimum value that the Gini measure of income inequality can take on is zero which is achieved when the per capita incomes are all equal.

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BIOGRAPHICAL SKETCH

Bakayoko Adama was born on December 24, 1949, in Lakota, Ivory Coast. He attended the local public primary school from which he obtained the Primary School Leaving Certificate (CEPE) in 1963.

In October 1963, he entered high school at the Collège Notre Dame d'Afrique in Abidjan, but later transferred to a public high school, the Collège Moderne de Sassandra. He graduated from the latter institution in June 1967 with the BEPC diploma, indicating completion of the first cycle of his high school education. He was also awarded the "Brevet Militaire" upon his graduation for successfully completing a formal course of military training. From October 1967 to June 1970 he attended the Lycée Technique d'Abidjan where he completed the second cycle of high school and graduated with the Baccalaureat d'Etudes Secondaires in June 1970.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.



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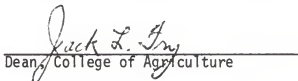
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